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Descripteur(s): *Technologie *Programme d'enseignement *Guide de l'enseignant *Cahier d'exercices *Secondaire (Niveau)

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Le programme d'initiation à la technologie offert au niveau secondaire fait l'objet de ce guide du maître, accompagné d'un cahier de l'étudiant. Après avoir abordé le problème de la définition de la technologie, le guide dresse un aperçu des programmes d'enseignement secondaire qui ont une composante technologique dans le monde, puis insiste sur l'importance d'équilibrer la théorie et la pratique dans un tel enseignement. Les activités proposées visent à faire prendre conscience à l'étudiant qu'il vit dans un monde technologique, que certaines étapes sont communes à toute technologie, que sa vie est entourée d'applications spécifiques de la technologie et que ce domaine est sans cesse en évolution.

Les activités décrites dans le guide et reprises par le cahier de l'étudiant sont centrées autour de huit thèmes: 1. la technologie dans la vie humaine; 2. les communications graphiques; 3. la créativité; 4. les matériaux et procédés; 5. les structures; 6. les machines simples; 7. la force motrice et l'énergie; 8. l'évolution continue de la technologie.

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INTRODUCTION TO TECHNOLOGY
TEACHER GUIDE

JOHN GRADWELL
MALCOLM WELCH

McGILL UNIVERSITY - 1983

THESE MATERIALS WERE DEVELOPED BY MEANS OF A GRANT
FROM THE MINISTÈRE DE L'ÉDUCATION DU QUÉBEC
AND THE PROGRAMME DE PERFECTIONNEMENT DES MAÎTRES
DE L'ENSEIGNEMENT PROFESSIONNEL AT MCGILL UNIVERSITY

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INTRODUCTION TO TECHNOLOGY PROGRAM
AS ORGANIZED
FOR P.P.M.E.P. RESEARCH PROJECT

J. Gradwell, McGill University

M. Welch, P.S.B.G.M.

TEACHER GUIDE

Slide Series

In these booklets reference is made to a series of slides which are essential to certain portions of the text. The series was assembled from a variety of sources and represents the kinds of ideas you will want to convey to your students.

It is recommended that teachers create their own set to suit their own individual needs. If necessary, the original series can be viewed by contacting John Gradwell at (514) 392-8844 or Malcolm Welch at (514) 637-2505.

INTRODUCTION TO TECHNOLOGY PROGRAM

AS ORGANIZED

FOR P.P.M.E.P. RESEARCH PROJECT

PREFACE

A DEFINITION OF TECHNOLOGY

REVIEW OF SECONDARY SCHOOL PROGRAMS WITH A TECHNOLOGY COMPONENT

THE RELATIONSHIP OF THEORY AND PRACTICAL WORK

THEMES:
0. Introduction
1. Technology in the Life of Man
2. Graphic Communications
3. Creativity
4. Materials and Processes
5. Structures
6. Simple Machines
7. Power and Energy
8. The Changing Nature of Technology

APPENDIX ONE - SLIDES

PREFACE

The objectives as stated for each theme embody the essential concepts of the course. The specific examples merely form starting points for the teacher who may wish to modify or change activities to meet the particular needs of a group. It is mandatory, however, that the objectives, as specified, be adhered to.

Many of the ideas included in these materials were adapted from activities in a number of other programs. In particular the authors wish to acknowledge Project Technology (England), Scottish Technical Education Modules (Scotland), and the Industrial Arts Curriculum Project (U.S.A.).

A Definition of Technology

The word 'technology' began as a hybrid, a linkage between two Greek words, techne meaning art or skill and logia meaning science or study, i.e. the science of an art or skill. From that point on the word was used to describe activities involving the use of manual skills and intellectual activities.

In standard dictionaries technology is variously defined as: theoretical knowledge of industry and the industrial arts, the application of science to the arts, systematic treatment, a discourse or treatise on an art or arts and the scientific study of the practical or industrial arts.

However, from the many perspectives and central themes evidenced in the literature on technology, it has become increasingly difficulty to determine a real meaning of the term. It can be stated categorically that 'technology is artificial (synthetic), a phenomenon created by humans'. Technology is not found in nature. Animals often use tools, but they do not create new tools or assess the ramifications of their use. It appears to be man alone who purposefully creates tools, uses them to do his own bidding, and then reflects on their use. Indeed for many it is man's unique ability to correlate and coordinate all or any of his attributes and direct them to specific ends which forms the essence of technology.

Technology is cumulative--that is, it is based on accumulated knowledge and technique and therefore is constantly changing. The construct of technology is never completely the same at any two points in time. New discoveries continue to add new understandings and new dimensions. The use of technology involves humankind linking technique (consisting of the laws of science and a knowledge of how things work) and action. Action, in this context, refers to the process of creating new systems: new tools, machines, processes, information and eventually techniques. Technique makes up our basic technological knowledge pool. The pool is constantly being expanded, by new knowledge generated from creating and using technological systems and by the changing human values accruing to the users of these systems.

Definitions of technology have all been representative of the periods when they were written. Many early studies emphasized the idea of "tool making" and "tool using". During the era of the sixties the pervading theme centred around productivity and efficiency.

To some, technology is "man's efforts to cope with his physical environment (Kranzberg and Pursell, 1967) or "the means by which man extends power over his surroundings" (Hamilton, 1973). Others state that tool making also involves techniques, "including such intellectural tools as computer languages and contemporary analytic and mathematical techniques" (Mesthene, 1970).

Acknowledging that technology is cumulative and constantly changing, Professor Jacques Ellul opts for the suggestion by H.D. Lasswell that technology is "the ensemble of practices by which we use available resources to achieve certain valued ends".

More recently the shift seems to be toward the effects of technology on society.

For teachers involved in the planning and development of technology courses, it is essential that a working definition be adopted.

Which definition to adopt is a fundamental question?

G. B. Harrison, commenting on the aims of the UK. Project Technology, noted that, "The very word technology presented problems. It had, and still has, an awkward ambiguity, meaning both the generalized influence which advancing industry has on society (as in 'The Influence of Technology on Society'), or it is seen as one of the specific technologies such as fuel technology, communications technology, chemical or food technology etc."

The Ministère de l'Education, in a series of curriculum guides for a Quebec based Introduction to Technology course, has defined technology in a number of ways. Beginning with its 1971 guide, for example, the Minister states that a definition "varies in accordance with the different spheres of human activity". For example, the guide states that "from a historical point of view, technology may be defined as a study of manufacturing processes, a study of industrial operations carried out in the light of the result it is proposed to obtain. In its general sense, technology may be described as an art which borrows certain principles from the exact sciences and which examines existing objects in order to design new ones which will fulfill well-defined needs." Last of all, "as an element of education, technology is considered to be the outcome of a more or less lengthy progress which originated in a need that could only be satisfied by technical means and whose outcome is undetermined."

Later, in its 1975 curriculum, the definition is modified to become "the totality of the means employed to provide objects necessary for human sustenance and comfort", and later (in the same document) "a field of human endeavour aimed at improving his living conditions".

The UK. Project Technology ultimately defined technology as being " a disciplined process by which the resources of knowledge (of materials, of energy, of the concepts of science, of technical concepts etc.) are used in the practical solution of problems identified by human needs". As Harrison points out, technology was not defined as a particular body of knowledge, or as one of the individual technologies for this would have had even greater implications for the problem of finding a place for technology in the school curriculum. The defintion led to a model for technology itself represented by the figure shown below.

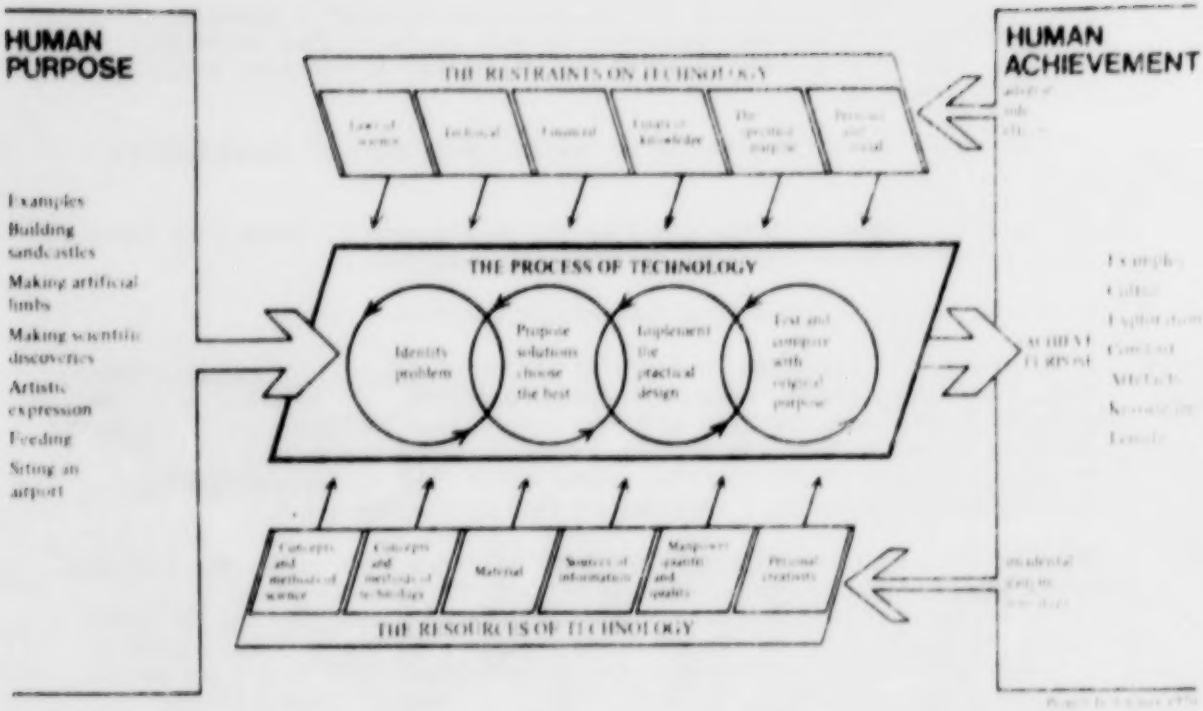


Fig 1 Technology - a disciplined process using scientific, material and human resources to achieve human purpose

It can be seen quite clearly that technology, when defined in terms of process, is quite simple. The essential components of the process of technology are:

1. To identify a problem.
2. To propose solutions and then choose the one which appears to respond best to the stated problem.
3. To implement (build) the practical design.
4. To test and compare the result with the originally stated purpose.

The reader may conclude from the many perspectives and central themes evidenced in the literature on technology that it is somewhat difficult to make sense of the real meaning of the term. The definition of technology and what it does changes over time.

For those people involved in developing and teaching school technology programs what becomes important therefore is to identify those aspects or components of technology which remain unchanged. These may then be used to create a working definition.

The materials presented here have been developed using the premise that the unchanging heart of technology is its design process. What is essential to technology is the skill of inventing, designing, planning, and problem solving. This emphasis on the process of technology provides a definition which not only endures but applies to the many individual technologies. At the same time we acknowledge that technology is a uniquely human activity, that it comprises an ever expanding body of knowledge and that it is a dynamic and pervasive force within society.

REVIEW OF SECONDARY SCHOOL PROGRAMS WITH A TECHNOLOGY COMPONENT

During the past twenty years there has been an increasing interest in designing courses which will introduce students to our technological society. The following extracts from School Technology Forum Teacher Education Report illustrate the diversity of approaches which can be used.

1. An isolated subject, called Technology, Engineering Science, or something similar, which attempts to satisfy all the school's technological objectives.

2. A course on an aspect of Technology which fits in as a complement to other courses. For example, Control Technology.

3. Advanced level GCE Engineering Science as a structural course designed to be acceptable as a straight alternative to Physics.

4. Engineering, Elements of Engineering Design, Applied Science and Technology, and other courses, designed to be taken in addition to the traditional mathematics and physics.

5. A course to introduce pupils to Technology through their subject by running mini-courses in specific fields; topics such as electronics, control, pneumatics etc.

6. The inclusion of Technology, in its various forms, in individual subjects of the curriculum.

7. Enabling students to experience the full design process (as opposed to manufacturing things to predetermined plans).

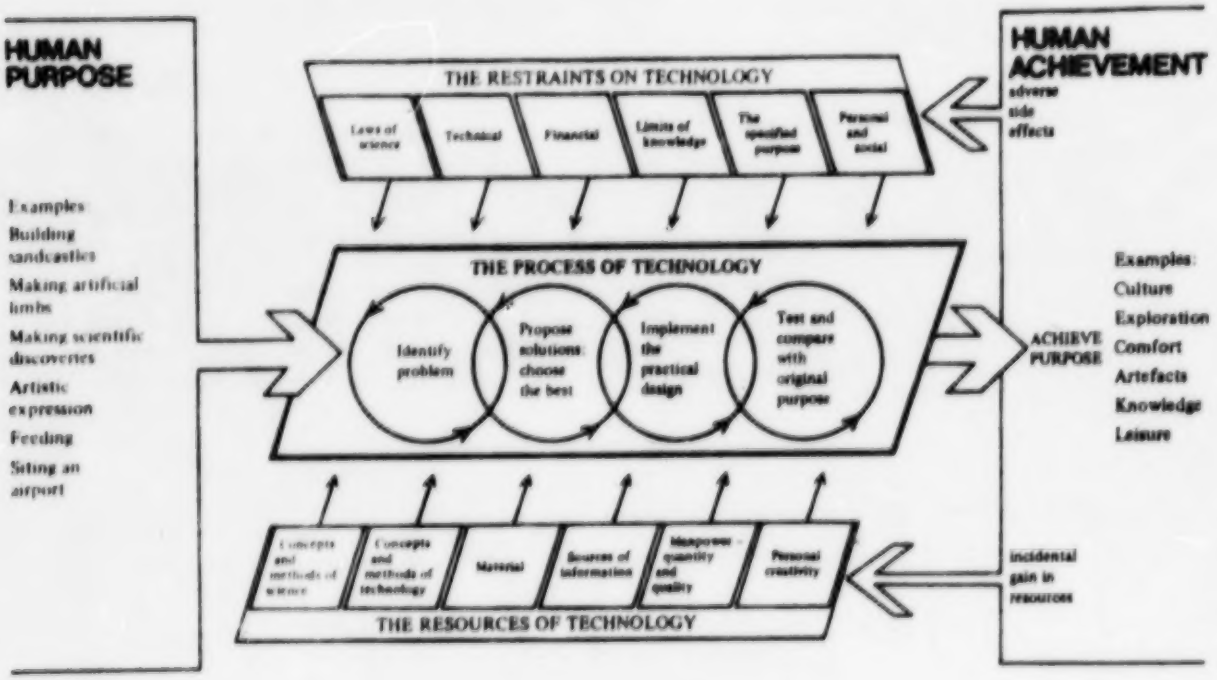
8. Taking Technology out of the specific subjects of Science and Craft and restructuring it without a specific subject base.

The range of programs is however broader than indicated by this list which considers primarily those programs operating in Britain. If programs in other countries are added one arrives at eight major categories as show below:

1. Technology as a Process
2. Modular Courses
3. Design Education
4. Technology/Culture Interface
5. Industrial Arts
6. Introduction to Technology (Quebec)
7. Craft Education
8. Pre-engineering

Technology as a Process

The British program known as Project Technology is seen as being different from traditional school subjects in that it requires and generates many links outside the school and that it demands the type and quality of thought and imaginative approach of the engineer and applied scientist. The diagram below shows that technology is perceived as a disciplined process using scientific material and human resources to achieve human purpose. The choice of purpose is made according to man's need and the satisfactory achievement of human purpose forms the basis of technology.



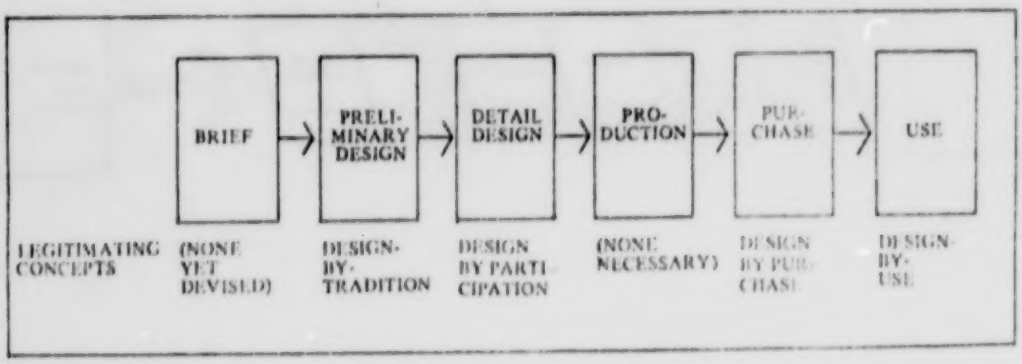
Modular Courses

Modular courses can be used to enrich existing courses in science, craft and design or they may be used alone to form a complete program. The modules listed below were developed by a project team based in Avon and Hertfordshire, England.

- Electronics
- Energy Resources
- Structures
- Mechanisms
- Materials Technology
- Technological Problem Solving
- Control Electronics
- Aeronautics
- Pneumatics
- Instrumentation
- Acoustics
- Optical Instrumentation
- Electrical Application
- Technology and Society
- Microprocessor Control

Design Education

The key element in focusing technology around the concept of design is the idea that the designer is the key technologist. Whether one believes that it is technology which shapes society or that society shapes its own technology, in the centre of that relationship lies the design activity. Designing represents decision making and provides the interface between technology and society. Those who accept this concept see design as a general subject because, to some considerable extent, what we are as individuals is defined and constrained by what we use. The essense of the design--production process is shown below.



Technology/Culture Interface

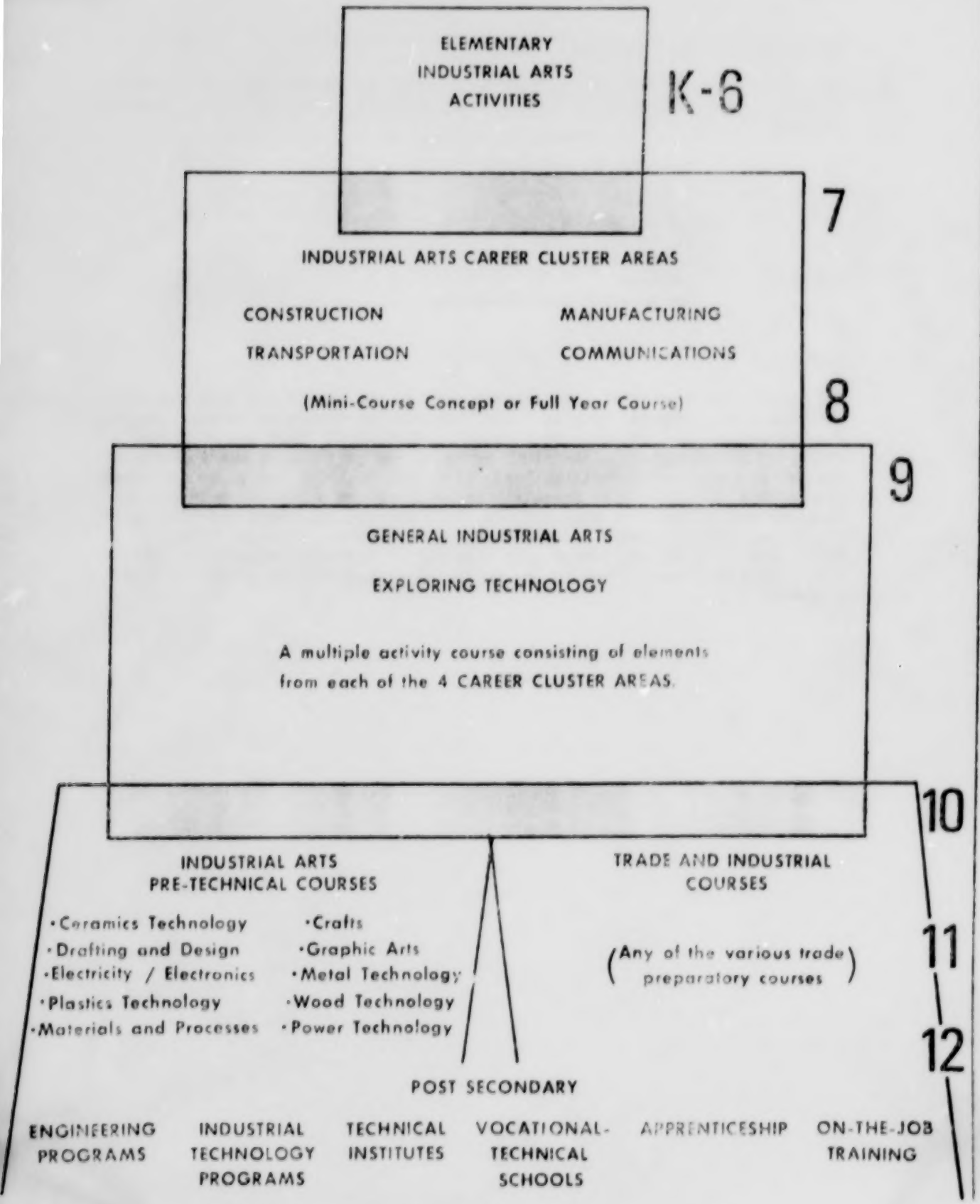
The central aim of this approach is to provide the technician with a human approach. Topics covered in this type of approach to technological education include:

Resource use and abuse
Cities
Transport
Communications
The Future of Man
Our Heritage
Purposes
The International Dimension

Industrial Arts

The origins of industrial arts stretch back to the end of the last century and draw upon movements such as Sloyd, the Russian system and manual training. With an extensive historical background it is expected that one will find a diversity of approaches. The older programs use unit shops, where discrete courses in woodworking, metalworking, printing, drafting and so on are given. This method is still very prevalent and retains its appeal largely due to hands-on activities. In many schools, this approach has been modified by clustering certain activities together. For examples, separate woods, metals and plastics activities join together to form one "materials" workshop. This method is shown in the following diagram at the grades 7, 8 and 9 levels.

SCOPE AND SEQUENCE



During the sixties and seventies many new I.A. programs were proposed. Only one has however attained a reasonable measure of success in terms of its broad adoption by a number of schools. This program is the Industrial Arts Curriculum Project which is taught in two parts, the World of Construction and the World of Manufacturing. A brief description of each program together with a list of learning experiences is included on the following pages.

It is interesting to note that modern I.A. programs frequently incorporate the term "technology" when defining the objective of their programs. The I.A. course for grades 7 and 8 in Pennsylvania states that "Industrial Arts is that subject area which is involved in providing youth with knowledge about the technological environment related to industry of the past, present, and future."

The World of Construction

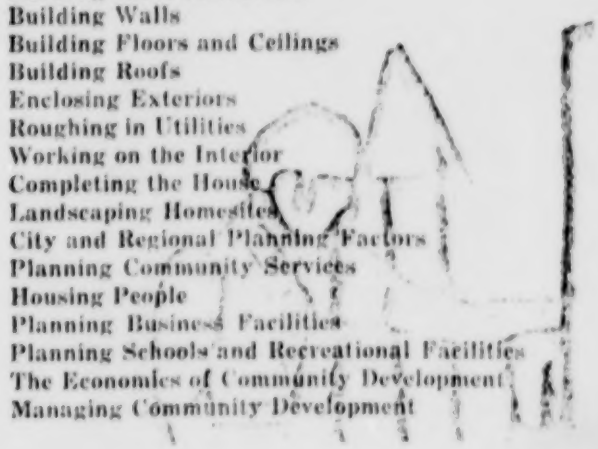
An Overview

This one-year exploratory course provides an opportunity to learn and apply basic knowledges and skills of the construction industry.

Students first read and discuss the practices which are required to build any structure, such as a road, dam, utility network, building, tower or tunnel. Concepts of construction then are applied in occupationally-oriented laboratory activities to reinforce the students' understanding of how man plans, organizes and controls all available resources to produce products on a site as varying as skyscrapers and superhighways.

Units Of Study And Learning Experiences

Man and Technology
Construction Technology
Applying Technology to People
Managing Construction
Beginning the Project
Selecting a Site
Buying Real Estate
Surveying and Mapping
Soil Testing
Designing and Engineering Construction Projects
Identifying the Design Problem
Developing Preliminary Ideas
Refining Ideas
Analyzing the Designs
Selecting the Design
Making Working Drawings
Writing Specifications
The Designing and Engineering Cycle
Selecting a Builder
Contracting
Estimating and Bidding
Scheduling
Working as a Contractor
Collective Bargaining
Hiring Construction Personnel
Training and Educating for Construction
Working Conditions
Advancing in Construction
Construction Production Technology
Getting Ready to Build
Clearing the Site
Locating the Structure
Earthmoving
Handling Grievances
Stabilizing Earth and Structures
Classifying Structures
Setting Foundations
Building Forms
Setting Reinforcement
Mixing Concrete
Placing and Finishing Concrete
Completing Foundations
Building Superstructures
Building Mass and Masonry Superstructures
Erecting Steel Frames
Erecting Concrete Frames
Building Wood Frames
Installing Utilities
Installing Heating, Cooling and Ventilating Systems
Installing Plumbing Systems
Installing Piping Systems
Installing Electrical Power Systems
Installing Electrical Communications Systems
Making Inspections
Mediating and Arbitrating
Enclosing Framed Superstructures
Roofing
Enclosing Exterior Walls
Striking
Insulating
Applying Wall Materials
Applying Ceiling Materials
Laying Floors
Finishing the Project
Painting and Decorating
Installing Accessories
Completing the Site
Transferring the Project
Servicing Property
Building Dams
Bridge Building
Road Building
Building Skyscrapers
Constructing in the Future
Constructing Housing
Your Dream House
Selecting and Purchasing a Lot
Planning the Living Space
Preparing Working Drawings
Writing Specifications
Financing and Contracting
Building the Substructure
Building Walls
Building Floors and Ceilings
Building Roofs
Enclosing Exteriors
Roughing in Utilities
Working on the Interior
Completing the House
Landscaping Homesites
City and Regional Planning Factors
Planning Community Services
Housing People
Planning Business Facilities
Planning Schools and Recreational Facilities
The Economics of Community Development
Managing Community Development



The World of Manufacturing

An Overview

The *World of Manufacturing* segment in the IACP program is designed to help youth understand the basic concepts of management, personnel, and production techniques for creating finished goods in a plant or factory. Students are introduced to the problems of custom-produced goods then to the benefits, basic concepts and methods of an organized manufacturing system that efficiently integrates men, machines and materials.

Students research, design, engineer, and produce many different products of varied matrials using selected processes. Learning experiences vary from consumer research and data collection to estimation of costs and principles of mass production. Activity includes role-playing situations, as well as "hands-on" lab experience in developing and mass-producing products.

Units Of Study And Learning Experiences

Man and Technology
The Evolution of Manufacturing
Manufacturing and the Economic System
Manufacturing Technology
Manufacturing Management Technology
Inputs to Manufacturing
Organization, Ownership, and Profit
Identifying Consumer Demands
Researching and Developing
Designing Manufactured Goods
Creating Alternate Design Solutions
Making Three-Dimensional Models
Refining the Design Solution
Obtaining Approval of Management
Engineering the Product
Designing Power Elements
Making Working Drawings
Building the Production Prototype
Technical Writing and Illustrating
Planning Production
Planning Processes
Automating Processes
Measuring Work
Estimating Cost
Tooling Up for Production
Installing Production Control Systems
Operating Quality Control Systems
Designing and Engineering the Plant
Establishing Accident Prevention Programs
Supplying Equipment and Materials

Processing Data or Information Using the Computer
Employment and Occupations in Manufacturing
Manufacturing Personnel Technology
Hiring and Training
Working, Advancing, and Retiring
Organized Labor and Collective Bargaining
Securing Reproducible Raw Materials
Extracting Raw Materials
Harnessing Energy from Nature
Manufacturing Production Technology
Converting Raw Materials to Industrial Materials
Making Industrial Materials into Standard Stock
Story of Primary Metal Products
Story of Textile Mill Products
Story of Petroleum Products
Story of Chemical Products
Making Components by Forming or Separating Standard Stock
Material Forming Practices
Casting or Molding
Compressing or Stretching
Conditioning Material
Material Separating Practices
Shearing
Chip Removing
Separating by Other Processes
Making Assemblies or Finished Products
Combining Components
Mixing
Coating
Bonding
Mechanical Fastening
Combining Subassemblies
Preparing for Distribution
Servicing Manufactured Products
Story of Printed Products
The Manufacturing Corporation
Forming a Corporation
Relating People to the Corporation
Making the Sales Forecast
Obtaining Capital, Estimating Profits, and Keeping Records
Locating the Plant and Securing Inputs
Designing and Engineering the Product
Planning Production Processes
Establishing Production and Quality Control
Making and Combining Components and Assemblies
Arranging for Distribution and Sales
Liquidating the Corporation
Manufacturing in the Future
Story of Basic Machine Tools
Story of Rubber Products
Story of the Telephone

Introduction to Technology (Quebec)

The first Quebec version of a course to introduce secondary school students to technology was adapted from a similar program created by the Ministère de l'Education Nationale (France). The Quebec program, developed between 1968 and 1970, concentrated very heavily on the design of objects which incorporated mechanical movements in addition to some activities related to drawing and electricity. A second version in 1975 kept the notion of creativity but applied it to nine themes to be taught in 180 periods. These themes were:

Technology and Mankind
Housing
Home Comfort
Heating
Lighting
Recreation
Telecommunications
Transportation
Automation

With the advent of the Régime Pédagogique in 1980 the new program was reduced to 100 hours and restructured into 5 themes. These are:

Technology in The Life of Man
Building Construction
Mechanical Technology
Electrical Technology
Technology in The World of Work

Craft Education

Craft education has its roots in the Arts and Crafts movement and the Sloyd System. Until the nineteen sixties emphasis was placed almost solely on the production of wood and metal articles by means of hand craftmanship. More recently other modules have been added to bring the program up-to-date. One example of this is the program currently advocated in Scotland:

Working in Wood
Working in Metal
Working with Plastics
Combined Craftwork I
Materials: properties and uses
Drawing I
Forces: an introduction to structures and mechanisms
Designing and Making: first steps in design
Drawing II
Combined Craftwork II
Designing for Craftwork: problem solving

Pre-engineering

Britain and Japan are two countries which have shown tendencies toward incorporating engineering within the secondary school system. In Britain this movement has been encouraged by the Engineering Industrial Training Boards (EITB) and by the successful course entitled Control Technology offered at the sixth form level (students generally aged 16-18 years). In Japan, engineering education in secondary schools enables pupils to experience practical application of principles or theories which are dealt with in physics

or chemistry. Experimental work helps link theory with practice and fosters the creative ability and rational performance of youngsters. The program of 3 years duration includes:

planning and drawing
materials and their processing
mechanical engineering
electrical engineering
gardening
practical applications

SUMMARY

An examination of the programs above led the researchers of this project to the conclusion that there were certain common characteristics within most programs.

- an appreciation that we are living in a technological world and that we must interact effectively with all aspects of technology which surround us daily.

- that certain steps are common to the process of technology, these being:

    - encouraging and increasing an individual's creative potential
    - the ability to visually record and communicate design ideas
    - the ability to work with a variety of materials in order to produce an object

- also that there are specific technologies which can be examined in order to place the processes mentioned above into contexts where we are likely to encounter technology at work in our everyday lives such as

    - building technologies
    - mechanical technologies
    - energy technologies

- finally it is important to stress the ever changing nature of technology and to emphasize this aspect by attempting to forecast the future.

These points formed the 8 themes around which these teaching materials are focused.

The Relationship of Theory and Practical Work

It is beyond the scope of these materials to list the variety of teaching methods available for use by a technology teacher. There is, however, one point which is a key element and is crucial to the success of this program; this is the emphasis which should be placed on a combination of theory and practical work.

Teachers who have previously taught Industrial Arts courses, particularly for the Protestant School Board of Greater Montreal (PSBGM) have depended heavily on the use of project work. Building or constructing articles has proved to be a method of reinforcing theoretical concepts in a way which is very motivating to students. Due to previous successful experiences these teachers are unwilling to adopt the Introduction to Technology program unless it also can combine theory with project work.

The insistence of PSBGM teachers is reinforced by many persons in several different countries. Geoffrey Harrison, a British educator speaking in 1979 at the Symposium on World Trends in Science Education questioned whether there was such a thing as theoretical knowledge. He suggested that theory does not become knowledge unless we are able to apply it to concrete situations. Students become confident only when visual evidence, through application, has proved that ideas work. Technology, therefore, becomes not merely the acquisition of facts but the active implementation of creative ideas to solve a real problem. From such examples long term understanding is achieved.

John Feirer, editor of the Industrial Education Journal in the United States examined this same question in his editorial of February 1983. He compared a new Introduction to Technology and Industry course with 17 different contemporary approaches to Industrial Arts which were promoted in the nineteen fifties and sixties. His conclusion was that there was only one successful program when judged in terms of its widespread implementation. The others failed because they did not emphasize the main and central theme of industrial arts and technology, that being "hands-on activities". He predicted that the new Introduction to Technology and Industry course would likewise fail if it were to be taught primarily by lectures and audio-visual methods with little or no hands-on experiences.

In Canada, Professor Long, Coordinator, Technological Studies, Queen's University pointed to the dichotomy which exists in the Secondary School Curriculum. His contention is that the curriculum largely concentrates on intellectual development except where psychomotor skills are offered as an option. He suggests that students become highly motivated when involved in a project which meets two criteria:

1. the project must be one which the participant has freely chosen, one which he believes to be worth doing

2. the project must be one with which the participant can strongly identify, either as an individual or as a group member

In summary, when one raises the question of whether the use of experimental work to demonstrate the practical application of theoretical principles is desirable the answer is clear. In North America and Britain, technology teachers are unanimous in their call for a balance of theory and practice by means of project work.

0.0 INTRODUCTION - Objectives

Students will be able to:

- recognize their dependency on the products of technology
- appreciate the extent and diversity of technology as a force in their lives

0.0 INTRODUCTION--Teacher Guide

0.1 The teacher should ask one or two students to describe their activities and to identify the technical objects and services required by those activities.

These should be listed on the board and their diversity and number pointed out to the class.

0.2 The teacher should make the point that each student is dependent upon the products of technology. That survival and comfort in a modern society are dependent upon the constant availability of technological products.

0.3. The teacher should assemble a series of slides of technical objects and services in order to illustrate the diversity of the technological world.

1.0 TECHNOLOGY IN THE LIFE OF MAN--Objectives

Students will be able to:

- Identify the diversity of technical objects and services encountered in daily life
- Differentiate between technical objects (a) essential for survival (b) whose absence would be a major inconvenience (c) which are luxuries and (d) which could be eliminated
- Understand that the purpose of technology is to design and produce objects which respond to the needs of man
- Produce a simple item according to a stated need using a series of logical steps

TECHNOLOGY IN THE LIFE OF MAN (5 lessons)

TEACHER GUIDE

1.2 After looking at the two slides (Nos. 1 and 2) students will list the articles they see in the slides under the following three categories (examples are shown within each category).

KITCHEN	LIVING ROOM
a OBJECTS ESSENTIAL FOR SURVIVAL	
Stove	A room to live in as shelter from the elements
Refrigerator	
b OBJECTS WHOSE ABSENCE WOULD BE A MAJOR INCONVENIENCE	
Dishwasher	Television
Clock	Furniture
c OBJECTS WHICH ARE LUXURIES	
Various decorations	Works of art
Fishes in bowl	Cable converter

Not everyone will agree as to the appropriate category into which any given object should be placed. This is natural: for example a working mother may consider a dishwasher to fall within category "b" whereas a housewife who remains home during the day may consider it a luxury. Consequently you should encourage students to give reasons for their answers. Sometimes it may be helpful to compare modern rooms with those of the last century to determine whether an object is really essential or otherwise.

1.3 The teacher should lead students to think about items which do not fit into any of the three categories in Section 1.2 above. These should be classified into a new category. Students should discover this category with help from the teacher. For example a typical grouping which the students may discover is one entitled:

OBJECTS WHICH WE COULD ELIMINATE AND WOULD NOT MISS

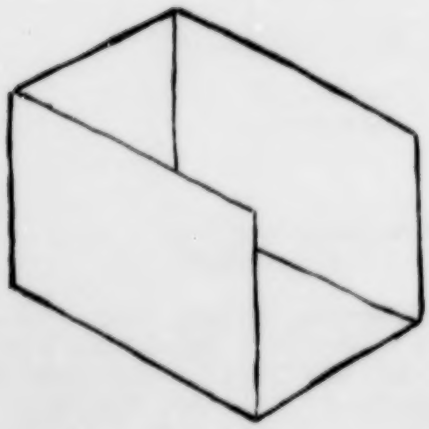
Into this category could be placed items such as:

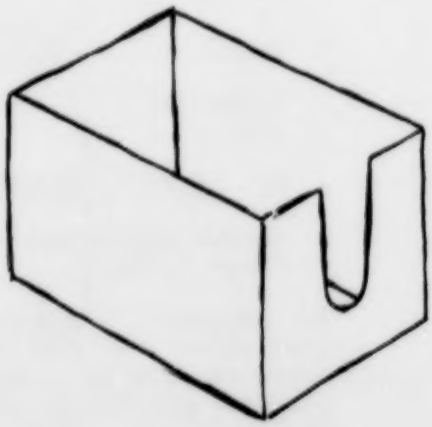
- junk mail
- parsley on a meal
- non-returnable drink cans and bottles
- throw away items and packaging of all kinds.

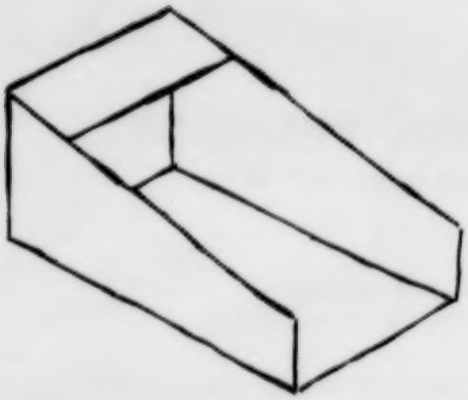
1.4 Paper which will be used in the paper holder is conveniently cut from 8½" x 11" paper (4 pieces per sheet). It is possible to recycle paper which has already been used (i.e. paper with writing on one side).

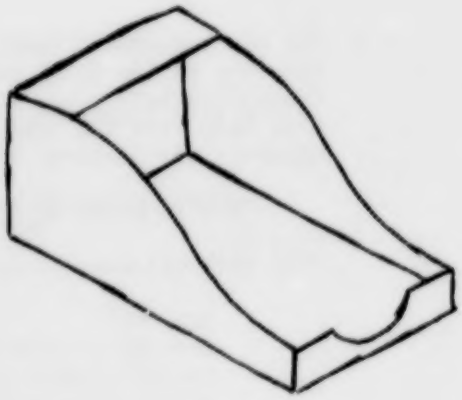
1.5 Encourage students to sketch several solutions. The teacher should not criticize or mark the students on their ability to draw at this time. Focus on the generation of ideas. The next chapter will deal with students' difficulties with sketching.

Below are typical examples of the types of sketches which students may draw.

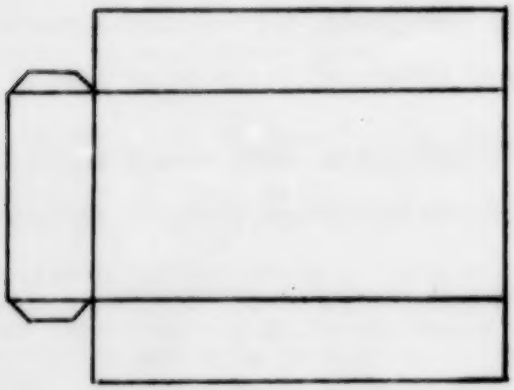








Some students may think of ways of joining one side to another. If no one in the class appears to be thinking of this aspect it is suggested that the teacher ask appropriate questions which will lead students to incorporate this aspect into their sketches. One example is shown below.



After sketches are complete the teacher may select several good designs and evaluate them by referring to the original problem statement.

1.6 The final part of this module requires the teacher to lead a class discussion to elicit from them the steps in the design process.

These steps can be described as follows:

a. stating the problem
b. recording ideas on paper (drawings, notes, etc.)
c. obtaining materials to make the project
d. cutting and joining materials
e. checking to determine the degree to which the solution satisfied the original problem statement

2.0 GRAPHIC COMMUNICATION--Objectives

Students will be able to

- Recognize different forms of communication
- Design a symbol to communicate information in a non-verbal way
- Identify examples of symbols which are encountered in everyday life
- Understand that drawings convey ideas more efficiently than words
- Communicate their ideas by means of isometric and orthographic drawings
- Determine which form of drawing is appropriate

GRAPHIC COMMUNICATIONS

TEACHER GUIDE

2.3 The teacher should ask students to match the symbol with its correct word. At the end of the exercise ask students to determine the reason for this task, i.e. that it is possible to communicate ideas without words. Briefly discuss the effectiveness of each symbol.

2.4 Hand out sheet (Communications Activity 1.) for students to draw their symbols. After symbols have been drawn collect them from the students and group them into the six different types. Make overhead transparencies for in-class discussion, i.e. the effectiveness of each one to transmit an idea without words.

2.5 Suggest to students that the symbol could show the activity with which the company is concerned. After completion of the Logos the teacher should display the students' work.
(Answer: the logo shown is used by the Michelin Company.)

2.6 Select one student and ask him to sit with his back to the class. Using the diagram provided the student will instruct participants how to draw it. Student should start with the top square and describe each in succession, taking particular note of the relationship of each to the preceding one. No questions are allowed. (see Figure 2.6)

2.4 COMMUNICATIONS ACTIVITY 1

1. Create a symbol (without words) to communicate the location of one of the following:

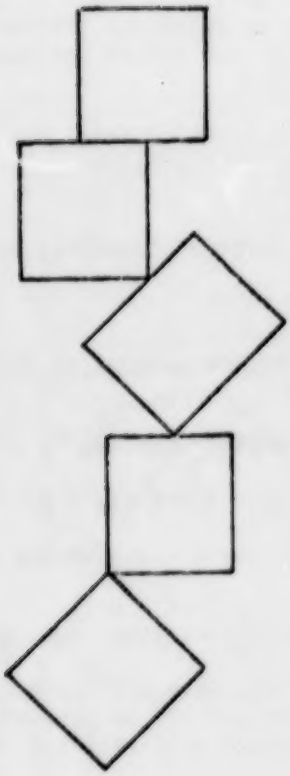
a) school dance
b) sports changing room
c) library
d) hand tools
e) power tools
f) I.T.T. room

2. Use the 6 squares below to develop your ideas and then draw the final solution, accurately, in the square at the bottom right corner of this page.

1	2	3
4	5	6

Your best solution →

FIGURE 2.6



2.7 Give each student a sheet of isometric paper (example attached). Teacher should make an overhead transparency of this paper in order to complete the following demonstration.

a) Teacher should draw the block (diagram 2.7a), line-by-line at the same time as the students starting with the three axes numbered.

b) Demonstrate the "removal" of a small block from the corner of the large block (diagram 2.7b).

c) To assist students with drawing their next block, which measures 16 x 14 x 12 squares, it may be necessary to show them the positioning of the 3 axes, as in part a) above. It will be helpful to circulate around the classroom to point out changes which need to be made (for example when a hole is cut out it has inside surfaces which must also be shown).

Encourage students to think of this exercise as a competition to produce the most interesting block.

2.8 Teacher should supply a sheet of isometric paper for the homework assignment.

2.9 The teacher should develop the concept of orthographic projection in the following way:

1. Show students the isometric drawing in Figure 2.9.
2. Ask students to draw the three views of this block in any order.
3. Ask students to place these views in the manner shown (third angle projection).
4. Show students how to project lines to avoid measuring.

Note: Some students may have difficulty visualizing the three views. A block of wood cut to the same shape with each view painted a different colour will assist students.

2.10 Teacher should supply squared paper to students. Samples of both isometric and squared paper are included.

There are many standard texts which will aid the teacher in understanding concepts in technical drawing. One example is

STIRLING, N., Introduction to Technical Drawing, McMillan Co., 1970.

ISOMETRIC PAPER

Fig. 2.7 ISOMETRIC PAPER

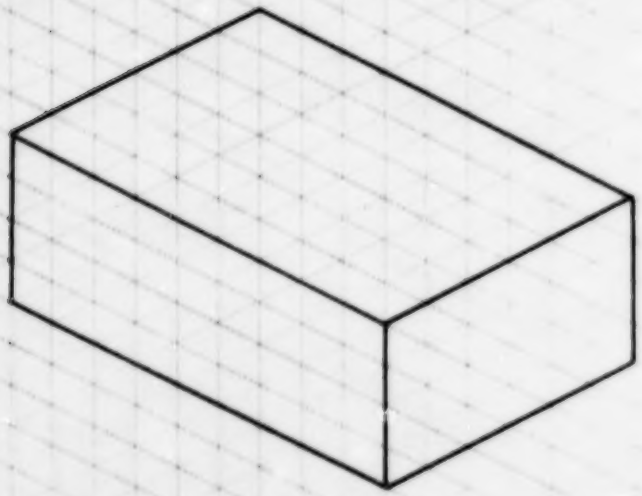


Fig. 2.7a

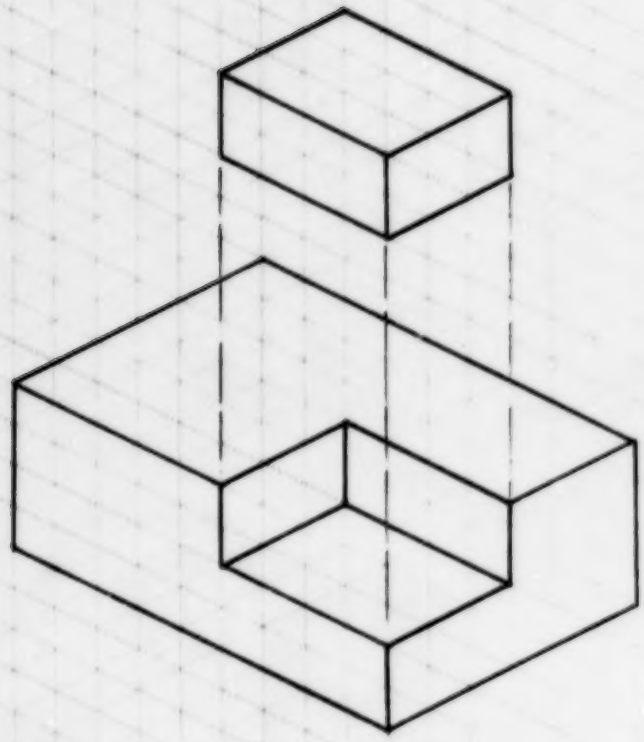
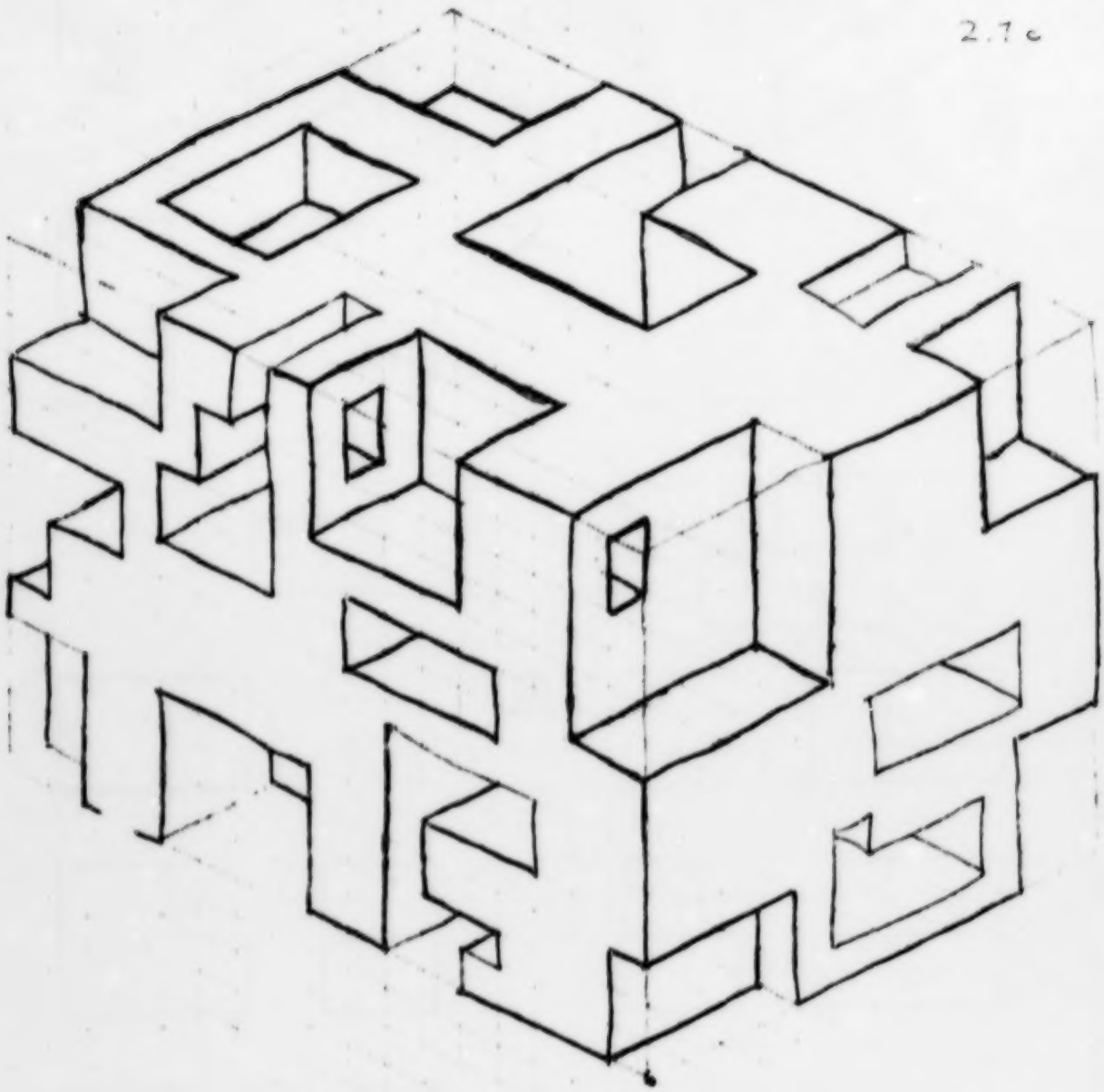


Fig. 2.7b

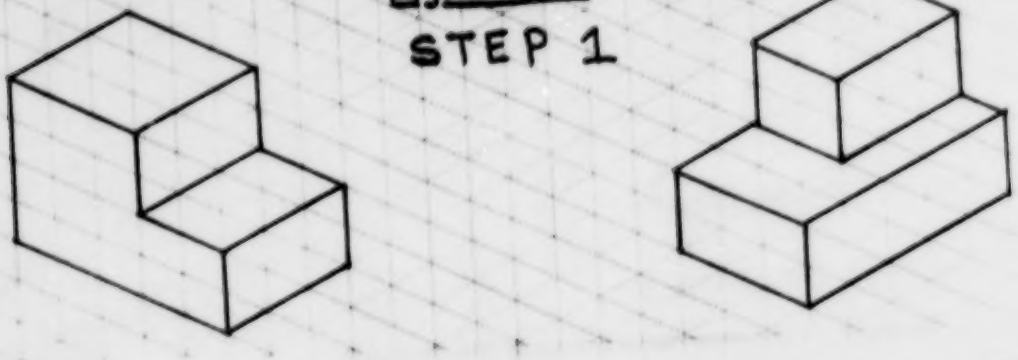
2.7c



SQUARED PAPER

Figure 2.9

STEP 1



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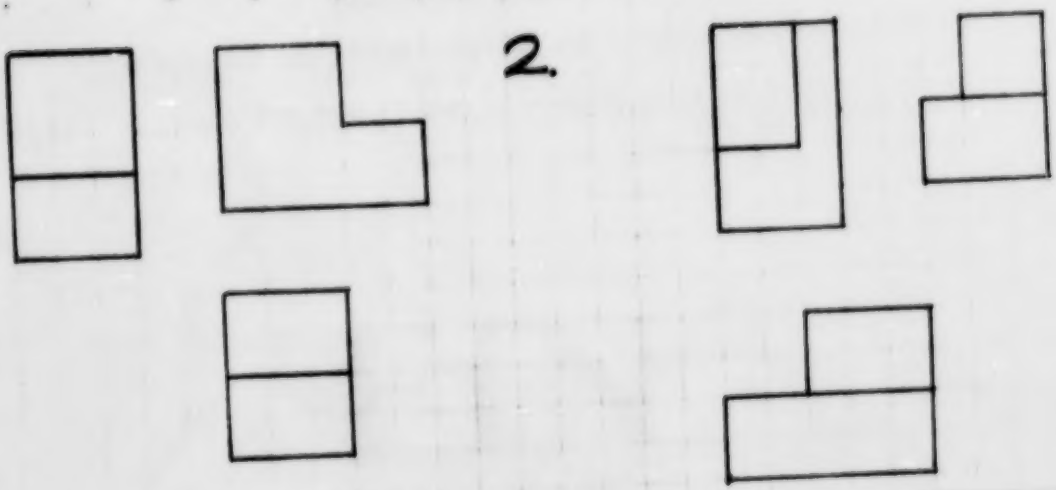

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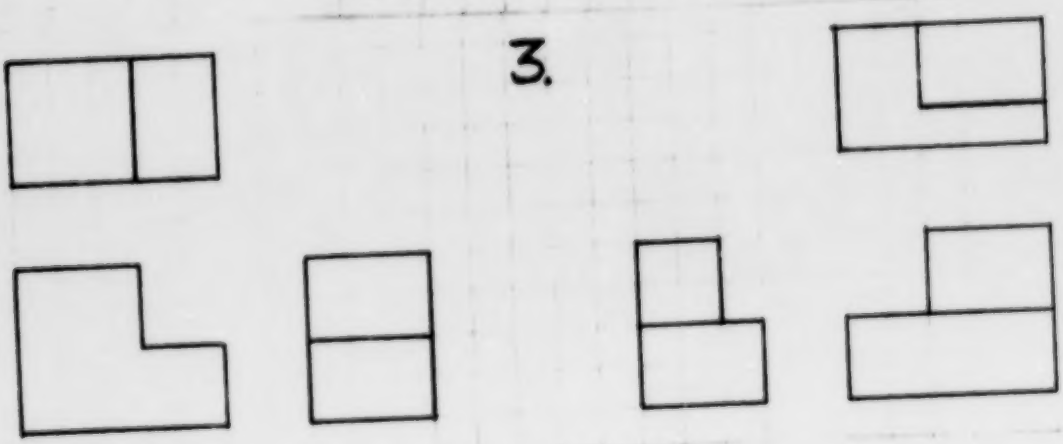

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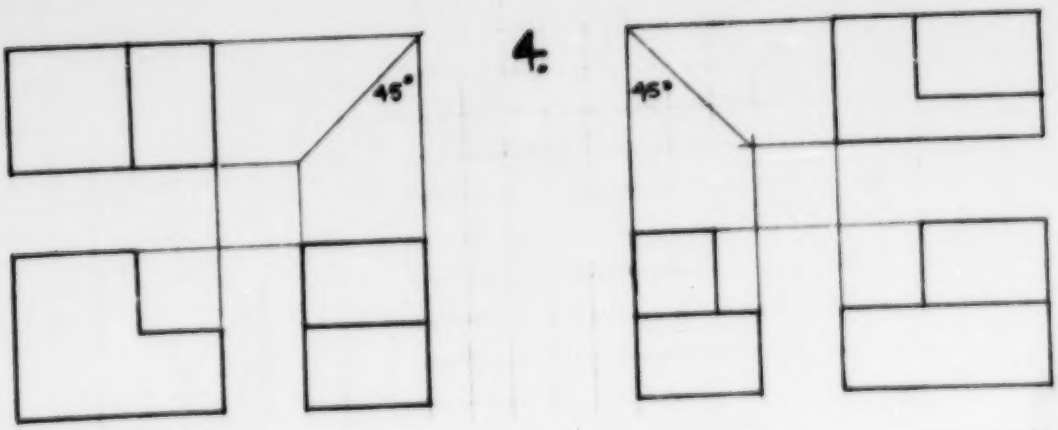


3.0 CREATIVITY--Objectives

Students will be able to

- Design a container to hold specific objects
- Recognize that products are designed to fit the human form
- Re-design an existing product to make it more efficient or to change its use

TEACHER GUIDE

3.2 One aspect of designing which is intentionally omitted at this stage is the type of materials to be used (wood, metal, plastic, composite materials, etc.) and their thicknesses. Students will need some help with this aspect. It is suggested that the teacher tell them that the boxes should be made of particle board ½" thickness for heavy objects (e.g. tools) and ¼" thickness for lightweight objects (e.g. sewing accessories).

The main criteria for evaluating the storage boxes is how functional they are. That is, the arrangement of compartment size to adequately accommodate tools or utensils.

3.3 This exercise may have to be completed using imperial measure (inches) as it is unlikely that metric measuring devices will be available in each student's home at this time.

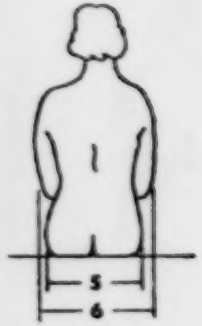
When the students return with their individual lists of dimensions you will need to collate the data on a master list. To do this the following steps are suggested.

1. Divide the class into 6 groups (one group for each of the body measurements).
2. Appoint a recorder for each group.
3. Go around the class and have each student call out his/her average for each body measurement (i.e. all A measurements first, followed by B and so on up to E).
4. The recorder in each group writes down the dimensions as they are called out and the individual groups total and average the figures.
5. These averages are then recorded by the teacher on a master sheet (overhead transparency sheet).
6. Compare the student figures with those provided on the attached sheet showing national averages. (Figure 3.3.6)

3.5 Some directions may be provided to the students by asking them to think of the different situations in which we find that special chairs are used (e.g. dentist, barber, airplane and various motor vehicles). The students will recall certain specific modifications such as height adjustments and stereo jacks in the arms. A major effort should be made to enable students to think as diversely as possible. Encourage students to imagine that they are designing a chair for a special occupation for persons with special needs.

Note: Some of the present modifications to chairs include pulsating devices (vibrators) for persons who are seated for long periods: chairs for elderly people which will tilt forward to allow for easy egress: chairs with adjustable support for the lumbar region of the spine.

	DIMENSIONAL ELEMENT	DIMENSION (in inches except where noted) 5th PERCENTILE	95th PERCENTILE
	Weight	102 LB	150 LB
G	0 Arm reach (finger grasp)	22.0	33.0
	1 Vertical reach	39.0	50.0
	2 Head to seat	27.0	38.0
	3 Eye to seat	25.0	32.0
	4 Shoulder to seat	18.0	25.0
	5 Elbow rest	4.0	12.0
	6 Thigh clearance	3.5	6.0
	7 Forearm length	14.0	18.0
	8 Knee clearance to floor	17.0	22.0
	9 Lower leg height	13.5	18.8
	10 Seat length	13.0	23.0
	11 Buttock-knee length	18.0	27.0
	12 Buttock-toe clearance	27.0	37.0
	13 Buttock-foot length	34.0	49.0
F	5 Hip breadth	12.5	15.4
	6 Width between elbows	11.0	23.0



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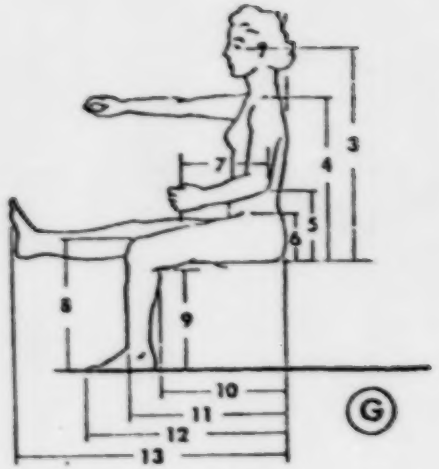
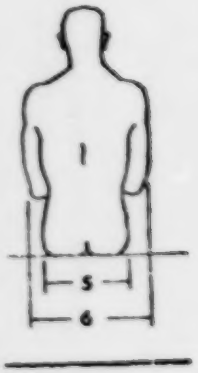


(G)

F	5 Hip breadth	13.0	15.0
	6 Width between elbows	15.0	20.0
G	0 Arm reach (finger grasp)	30.0	35.0
	1 Vertical reach	45.0	53.0
	2 Head to seat	32.8	38.0
	3 Eye to seat	29.4	33.5
	4 Shoulder to seat	21.0	25.0
	5 Elbow rest	7.0	11.0
	6 Thigh clearance	4.8	6.5
	7 Forearm length	13.6	16.2
	8 Knee clearance to floor	20.0	23.0
	9 Lower leg height	15.7	18.2
	10 Seat length	14.8	21.5
	11 Buttock-knee length	21.9	26.7
	12 Buttock-toe clearance	32.0	37.0
	13 Buttock-foot length	39.0	46.0



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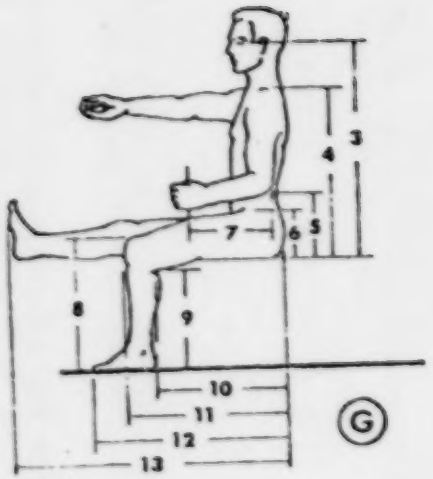


(G)

Figure 3.3.6

3.6 To illustrate the 8 ideas for changing an existing object the teacher can examine any existing object and suggest ways that the object has been changed in the past or could be altered in the future to make it more efficient. For example, the garbage container will illustrate these 8 points.

Used for a different purpose. Certain garbage cans could be used (a) as a pail (b) as a plant holder.

Borrowing a principle from an object. The pedal bin uses the principal of a lever to create a can which can be opened without use of hands.

Changing the shape of the object. Brown Supermarket Shopping bags are available widely. Perhaps the garbage bin should be altered in shape to accommodate such bags.

Re-inforcing critical parts. Some pedal bins break where the hinge and the lid join.

Eliminating parts. If the pedal has a plastic cap this could be eliminated, the metal pedal itself serrated.

Substitution of materials. Metal cans could be made of plastic to avoid rust and increase hygiene.

Rearranging parts. Earlier pedal bins had a pedal which proturded from the front. More modern ones are recessed.

Combination of existing ideas. The principle of the lever has been combined with a simple container.

At other times the teacher may wish to mention only a few of the above points in reference to a particular item. For example in reference to the telephone one could mention:

Used for a different purpose. A telephone can be combined with a burglar alarm system so that the police are automatically called in event of a break-in.

Changing the shape of the object. A visit to Téléboutique will illustrate the myriad of different shapes available.

Reinforcing critical parts. The household telephone is almost indestructable. Nevertheless, the one found in a public phone booth has had a metal casing added around the cord.

4.0 MATERIALS AND PROCESSES--Objectives

Students will be able to

- Identify a number of different materials
- Design and make simple objects using wood, metal and plastic materials
- Identify the correct processes to be used with a given material
- State characteristics of selected materials

4.0 Materials and Processes:

Teacher's Guide:

4.2 If students are having difficulty naming many different materials it will be helpful if you mention specific objects and ask them to identify which materials were used in their manufacture. For example, a car contains glass (windshield, headlights), steel (body and wheels), plastics (tires and trim): a lamp may include glass (bulb), plastic (switch), wood (base), chromed steel (vertical part).

The list may be varied and quite lengthy. It should later be grouped by the class in to the following types of materials: woods, metals, plastics, others. Some examples are shown below.

WOODS	METALS	PLASTICS	OTHER
pine	iron	acrylic	glass
walnut	steel	polystyrene	fabrics
oak	copper	A.B.S.	rubber
maple	brass	nylon	cottons
balsa	zinc	polyethylene	concrete
spruce	lead	P.V.C.	ceramics

It is recommended that the teacher consult textbooks dealing with materials in order to better understand the subject. For example, fiberglass is a mixture of glass fibres and plastic resin and therefore would be listed under "other" above.

4.3 In order to accomplish this activity the benches should be moved to form three distinct groups. One group will have tools used for making wood projects, a second for metal projects and a third for plastics projects. Students will rotate until they have completed all three projects.

Be sure to approve student sketches before issuing material to a particular student.

Basic tools and techniques for each material should be demonstrated. The objective is to show the capabilities of each tool (e.g. to cut, shape, file, sand etc.). Demonstrations should be made on a scrap piece of material and not on a project made to your design as students will tend to copy the one made by you. Correct safety procedures should be emphasized.

MATERIAL*		TOOLS	PROCESSES TO BE DEMONSTRATED
Material	Dimensions		
Wood (mahogany or Butternut)	50 mm^3	Try Square & pencil	Marking lines
		Tenon Saw	Sawing straight lines
		Surform files	Filing concave and convex curves
		Rasp	Filing concave and convex curves
		Centre punch & Hammer	Marking holes for drilling
		Drills	Drilling hole for candle or pencil(s)
		Sandpaper	Sanding surfaces
		Finishing supplies	Applying oil or other finish
Metal (aluminum strip)	3mm x 20mm x 200mm	Scriber and try square	Marking lines
		Hacksaw	Sawing straight lines
		Files	*Filing straight edges & curves*
		Hammer and centre punch	Marking holes for drilling
		Drills	Drilling hole(s)
		Letter stamps	Marking student's name
		Emery cloth	Cleaning surfaces
		Spray paint	Painting
Plastic (coloured acrylic sheet)	3mm x 25mm x 25mm	Hacksaw	Sawing straight lines
		Files	Filing straight edges & curves
		Hammer and Centre punch	Marking holes for drilling
		Drills	Drilling hole(s)
		Cabinet scraper (blade)	Smoothing edges (sandpaper can be used as an alternative)

*The type and size of material may vary according to stock available.

Portable, but sturdy, benches with vises are needed for each activity.

The class should be organized into 3 groups (approximately 7 per group), the groups working simultaneously with the 3 materials.

When the teacher becomes familiar with the processes listed above he may wish to experiment with other processes. For example, wood can be laminated and plastic can be shaped by heat.

Similarly the teacher may wish to substitute projects. Dice, dominoes and paper weights would also be items which would motivate some students to be involved in this design activity.

5.0 STRUCTURES--Objectives

Students will be able to

- Recognize the many different types of structures both natural and man made
- Define the term "structure"
- Compare the rigidity of a variety of shapes
- Design, build, test and evaluate a structure in model form
- State reasons for the size and arrangement of living spaces in a home
- Design and build a model of a home for a family of four persons

5.0 STRUCTURES--Teacher Guide

5.1 Using the students' ideas, as compiled in their charts, develop a master list of structures both natural and man-made. Try to concentrate on producing a list of very different types of structures rather than a very long list. Show slides* and ask students to:

- check how many of the structures shown were included in their individual lists

- try to identify what is common to all these structures

The students should be gradually led to the definition of the word STRUCTURE as being:

A connected system of parts (members) built to serve a particular purpose and to withstand safely loads applied to it.

There are three parts to this definition as shown by the way it is underlined above. The definition should be obtained by concentrating on these parts individually, and asking such question as:

- does each structure normally only contain one part?
- were all the parts built for specific purposes?
- what is really important about a bridge?

*The slides supplied with these teaching materials are examples of the kinds of structures you would want to use to illustrate both natural and man-made structures. The series should be modified to meet individual teacher needs.

SLIDE SERIES: STRUCTURES

Show slides numbered 4 - 15 to students and read text below which explains each slide.

4. WOOD CELLS: The internal structure of a tree is designed to provide passageways for the transportation of nutrients. Notice how the cells vary in size. Rapid growth takes place in the spring when greater amounts of food and moisture are available. This rapid growth produces a wide, porous layer of cells called spring or early growth. As the season progresses layers of darker, heavier, thicker walled cells develop, called summer or late growth. The size, shape and arrangement of cells also varies according to the species of tree.

5. OCEAN LINER: The Liner Canberra derives many of its features from the potentialities of its material, not least its overall form. Due to the lightness of aluminum an extra deck could be accomodated.

6. STONEHENGE: Monumental stones, some beautifully shaped, stand as testimonials to their own durability as well as to the skill and intelligence of their primitive assemblers. This rugged post and lintel principle was refined by the Greeks, but stone's innate strengths and weaknesses still dictated maximum lengths of beam and minimum thickness of supports. Structure and materials are closely related.

7. THE PARTHENON: The structure & shape of this Greek temple were determined by the strength of its material, for the space between any two columns could be no greater than the largest possible stone crossbeam.

8. HUMAN BONE: Bones are shaped to withstand the stresses to which they are subjected. If you look inside a bone you would find that it is hollow, with tiny supports stretching from one wall to the other. These supports develop in the direction of the stress lines: that is to say they are constructed to give each bone support where it is needed.

9. MYTHE BRIDGE: If you compare the structure of this bridge with that of a human bone, you will see how close to nature's own methods the designer has come. The Mythe Bridge, designed by Thomas Telford and built between 1923 and 1926, is almost entirely in cast and wrought iron. In casting components are formed in moulds of sand, packed around patterns. The patterns are removed before pouring, then used again to multiply the product. The bridge is conceived in terms of iron components multiplied. This gives unity to its parts. Cast iron is brittle and can snap under tension, or if hit sharply or bent. It will, however, take very high compression. Slender columns will take great loads.

10. CRANE: A crane's structure also resembles that of a human bone. Design engineers know that when an upright is evenly loaded, the stresses occur throughout its thickness; but when the load is on one side the stresses, partly tension and partly compressesion, are greatest at the surface, while the middle bears hardly any stress at all. To leave out the centre portion of such an upright will therefor not weaken it. A hollow tube, or specifically shaped lengths of metals, weighing much less than the solid upright, will do the same job.

11. EIFFEL TOWER: Designed by Alexandre Gustave Eiffel for the World's Fair of 1889, the Eiffel Tower rises to a height of 984 feet from a base 330 feet square. The tower contains 7000 tons of iron and steel and cost $1 million when it was built.

12. MAILLART BRIDGE: A bridge consists basically of two parts: the deck (continuation of the road) and the supporting arch. For an evenly spread load the best supporting arch would be a curve similar to that of a hanging rope, but turned upside down. But since bridges have to be able to withstand a great variety of uneven stresses this curve must be modified. To build an efficient structure the arch must be made strongest where the distortion is greatest.

13. REINFORCED CONCRETE STAIRS: Concrete is more capable of resisting compression than tension. If steel rods are inserted into a concrete structure where tension is likely to occur, the structure will be greatly strengthened. The insertion of steel rods to increase the tension resistance is the basic principle of reinforced concrete.

14. SHELL: The internal structure of a shell shows how it grows. Each time it adds another chamber, it makes it a bit larger than the previous one. In the end all the chambers link up.

15. GEODESIC DOME: Invented by Buckminister Fuller, the geodesic dome is a strong, lightweight structure built on a framework of triangular-shaped blocks. It requires no internal supports.

5.2 The shapes should be tested by applying a load as evenly as possible.

5.3 Using a simple piece of balsa wood to span a distance of 200 mm, apply a load to the centre to demonstrate the deflection which takes place. Point out to students that their design should stop such movement by using the triangle principle discovered in the previous exercise.

The teacher will need to develop a test rig to determine the load which each bridge can withstand. The type of test apparatus constructed will depend on materials available to the teacher.

5.1 (Reference Material)*

Structures

A structure is a device for providing support. Many common objects incorporate a structure; the materials from which it is made and its shape depend on the particular function it is required to perform. Natural structures include the shell of an egg and the bone and muscle of an animal. Much can be learnt from studying many objects, not only by handling them but also by close observation under a microscope. The shape of each component of a structure will give indications of how it is able to carry loads and withstand blows. For example, the way in which bones are hinged and attached to ligaments and muscles will show the type and direction of force each part is shaped to withstand. The shape of wood fibres will show how each cell makes its contribution to the strength of a tree.

In most man-made articles structural strength is important, although in some cases it is not the most important factor.

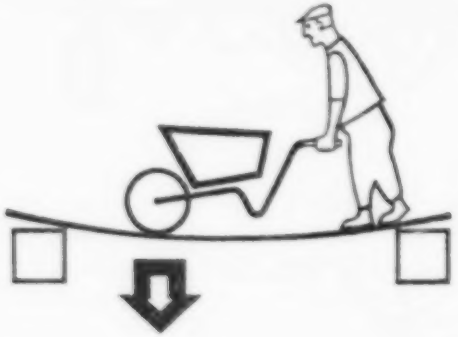
It is very useful, and often vitally necessary, to think about the manner in which force might act on an item you are about to construct. Success in any craft project depends on the ability of the object to maintain its correct shape under working conditions. In other words the mechanical requirement of any structure is to successfully resist all reasonable forces imposed on it.

The magnitude (size) and direction of these forces often vary between certain limits. Frequently other factors are important in a structure, examples being appearance, weight, cost, constructional time, resources and durability. Some of these may be more important than others. When thinking about different types of forces encountered by everyday structures it is necessary to consider six main types: bending; compression; tension; torsion; shear and centrifugal force. Some structures are subjected to only one of these, others have to resist two, three, four or even all six under their full working conditions. Descriptions of these forces acting on different structures are given on the following pages.

*These materials adapted from Barnes, R.W. and Knight, G.C. A Craft Approach to Technology, MacMillan, 1974, London.

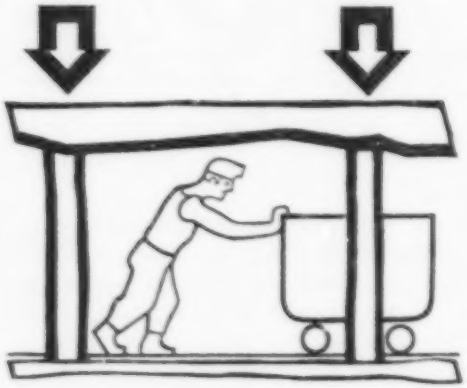
BENDING

The strength of the plank (or a bridge) must be enough to resist the weight of the wheelbarrow without being bent (deflected) to a dangerous degree. This type of structural member is called a beam. Beams for spanning large gaps have to be stronger than those for short spans, even where the loads are the same.



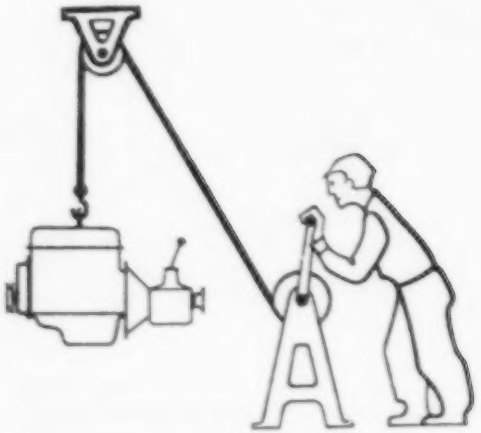
COMPRESSION

A pit prop resists a compression load. A compression member is called a strut. Miners prefer wooden props because they creak when under a considerable strain, thus giving warning of danger. A long one has to be thicker than a short one to resist the same load without breaking or bending greatly; furthermore, the strength of a strut is greatly affected by the type of fixture used to hold the ends in position.



TENSION

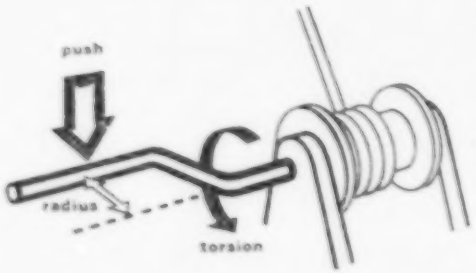
In the drawing, the rope must be strong enough to take the pull caused by the weight of the engine. A member for carrying a tensile load is referred to as a tie, and within reasonable limits the length of the tie makes no difference to the load it can take.



TORSION

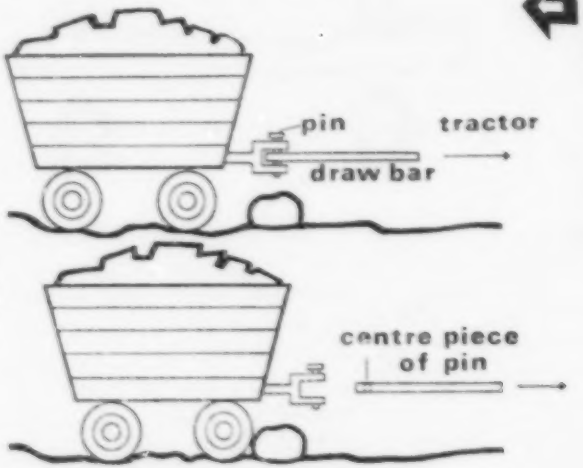
Torsion is a turning (or twisting) force and is calculated by multiplying the distance (radius of handle) by the force (push on the handle).

Another example is a spanner tightening a nut (investigate the torsion or torque wrench). This principle is used to ensure the correct tightening of nuts on highly stressed parts of cars and aircraft.

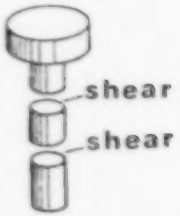


SHEAR

When a material 'shears' it is parted by an excessive force that tends to slide the material apart. In the drawing a trailer hits a bad bump in the road. The effect is of a sudden strong pull on the drawbar by which it is being towed. The force causes the pin retaining the drawbar to shear.

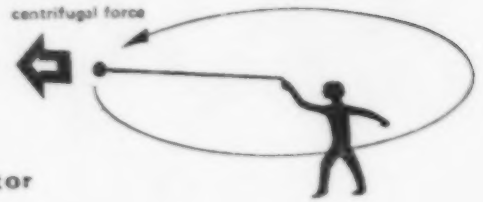


The ruined pin looks like this.



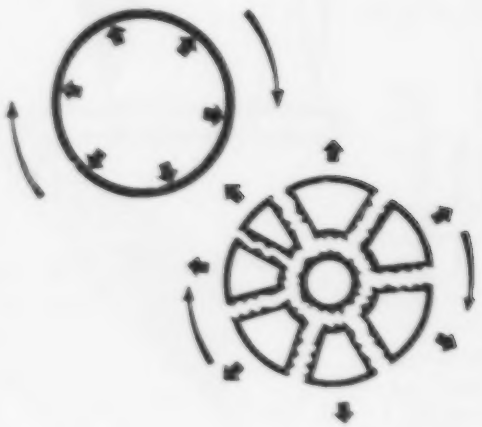
CENTRIFUGAL FORCE

If a weight attached to a length of string is whirled round, the string will become tightly stretched as the weight attempts to break free.



Similarly a wooden disc being turned into a bowl on a lathe will be affected by the rotary motion, each part of the rim will try and wrench itself away from the centre of the bowl. If the speed of revolution is too high the rim will break off, especially if there is a defect in the wood.

The danger of such situations cannot be over-emphasised; this explains why eye shields should always be worn by machine operators. When a particle is chipped off a grindstone it flies out at about 30 metres a second, too fast even for a person with exceptionally quick reactions to move out of the way if he is closer than about 6 metres to the wheel.

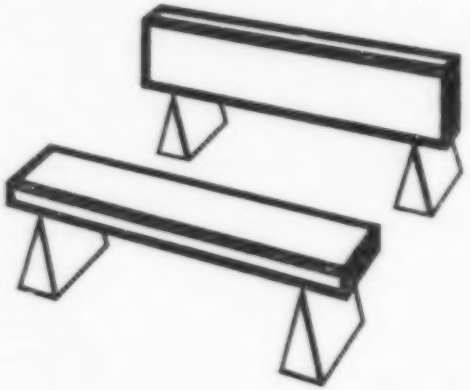


BEAMS

As mentioned earlier a member used mainly to resist bending is known as a beam.

Some simple tests using cardboard beams will show you some of the important facts about beams.

You will find that a deep narrow beam can take a larger downwards load than a wide but thin beam; this is true only if the beam remains in the correct position and does not twist.

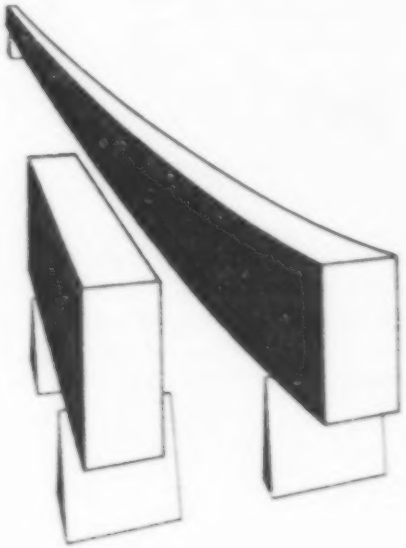


From this it follows that a thin beam will bend more easily than a thick beam of the same length and width if both are subjected to the same load.

As the span is increased the stiffness of the beam must be increased.

The best way of increasing the strength and therefore the stiffness of a beam is to increase its thickness rather than its width.

Unfortunately any increase in size of a solid beam will result in an increase in weight. This weight increase is a serious drawback. A long beam, for example, will bend considerably under its own weight.



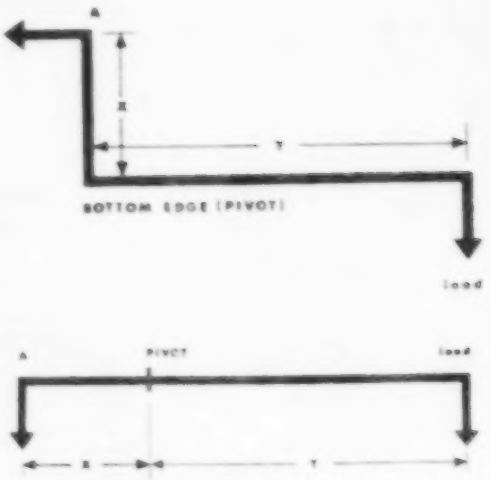
BEAMS IN SPECIAL CIRCUMSTANCES – THE CANTILEVER

A special case is the cantilever beam. An example of this application is a towel rack of the type commonly made in school workshops.

When a towel is hung on the rails the back plate attempts to pivot about its bottom edge. The screw B does very little work, screw A taking most of the tensile load (which tries to pull it out of the wall). The bottom edge takes the compressive force (which tries to press it into the wall).

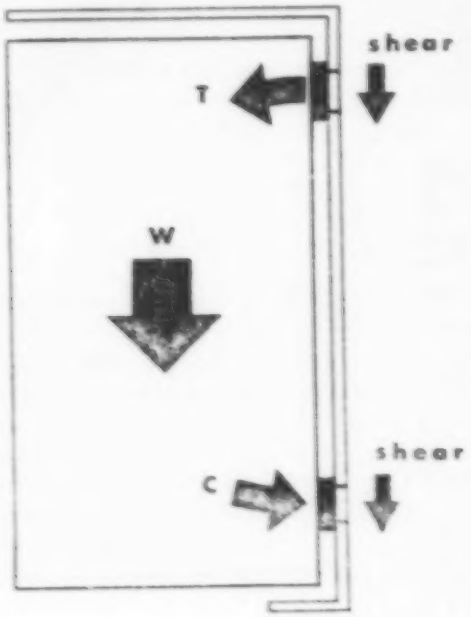
Here is the same situation represented diagrammatically and simplified by altering the direction of A as in lower diagram.

By taking moments, load x Y = force on screw x X. The same principle applies to the rivets E and F. Can you say which of the two rivets is taking the largest load? A simple testing device could be made using this principle to find the maximum tensile loads which different sizes of screws will take when screwed into different timbers.



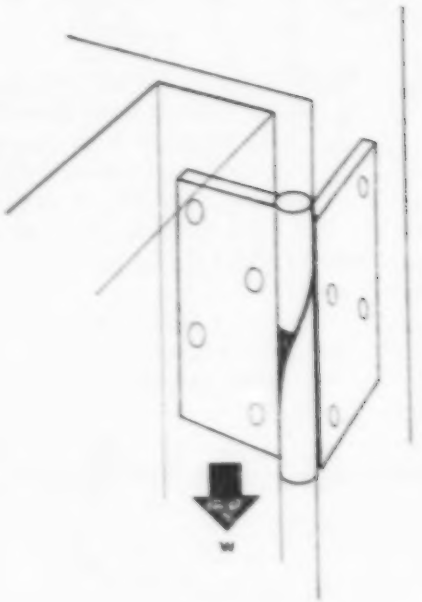
The same situation exists when a door is hinged to a frame.

The top hinge is in tension, the bottom hinge is under compression. The weight of the door also tries to shear the screws.



In homes doors sometimes have to be hinged so that they clear carpeting as they are opened or closed. Special hinges are used called 'rising butts'. Because of their shape (see below), rising butts tend to lift the door slightly as it is opened.

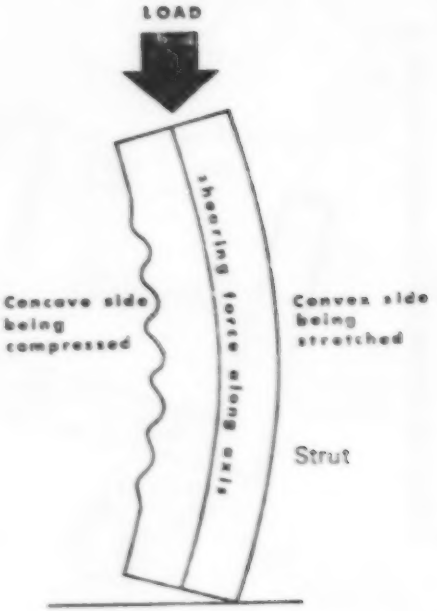
Work out why a door will tend to swing closed on its own if fitted with these special hinges.



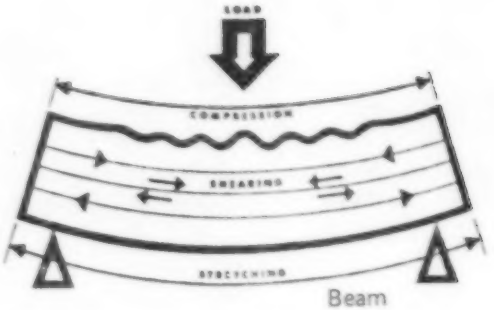
BEAMS IN SPECIAL CIRCUMSTANCES – PILLARS AND STRUTS

Pillars or struts have been described earlier as members under compression. It has also been pointed out that the length of a strut and its fixing have a great bearing on its ability to resist loads. If the strut could be kept straight whilst under load it would be able to take the same load no matter how long it was. Unfortunately, in most cases, due to unavoidable uneven loading, a strut begins to bend as soon as it is loaded. This makes it act like a beam, having its material on the convex side in tension and that on the concave side in compression, the neutral axis of the beam (approximately the centre) taking only a shearing load.

Before making an object some method is required to determine how it might be affected by forces in different situations. This analysis will repay the constructor's effort and time by helping him to anticipate possible causes of failure, and thus to ensure the success of his work.



Strut

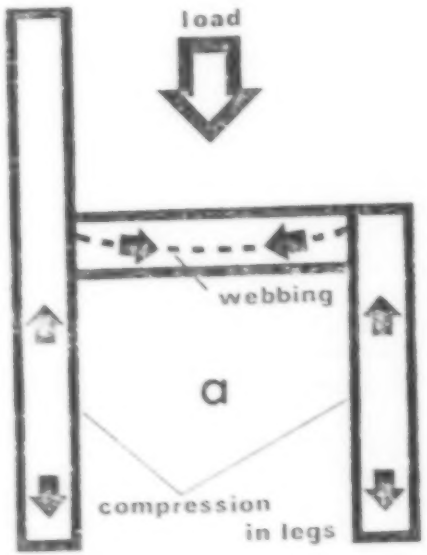


Beam

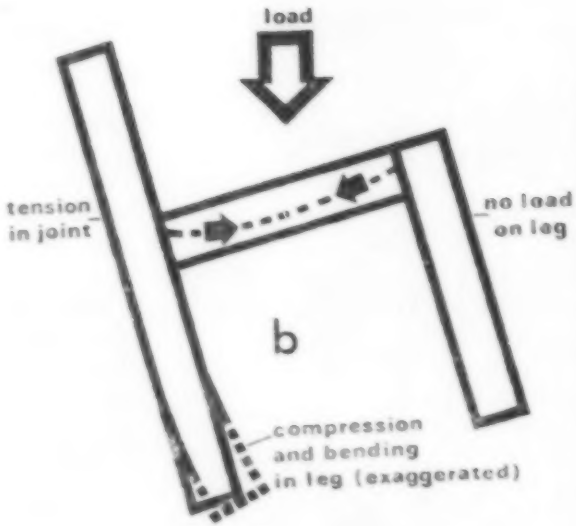
FORCES ON FURNITURE

The forces acting on a chair can change considerably according to the way in which it is used.

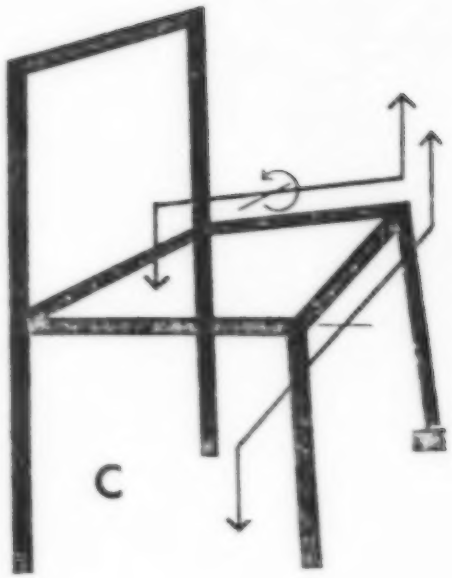
Under normal conditions the legs will be under compression, the rails under bending, the webbing of the seat under tension, and the joints between the legs and rails under shear loadings.



If the chair is tilted backwards whilst in use (as chair b is) the distribution of loads will be changed. The back legs take a bending force in addition to a compression, and the front legs are relieved of any force.



When the chair is placed on an uneven floor (see chair c) the stress will be particularly severe on the structural members and joints.



Using the method given previously, here is an analysis showing the main forces acting on the chair.

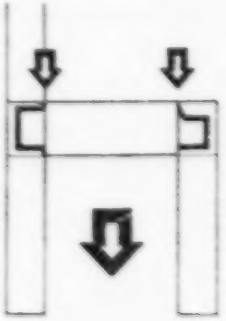
Position	a	b	c
Webbing	Tension	Tension	Tension
Front legs	Compression	–	Compression
Back legs	Compression	Bending	Compression
Side rails	Bending	Bending	Bending and twisting
Front and back rails	Bending	Bending	Bending and twisting
Front joints	Shear	–	Shear and twisting
Back joints	Shear	Tension Shear Compression	Shear and twisting

A rail, made of a size sufficiently large to prevent it twisting, will cause excessive loads to be thrown on the corner joints. Why is this?

SHEAR

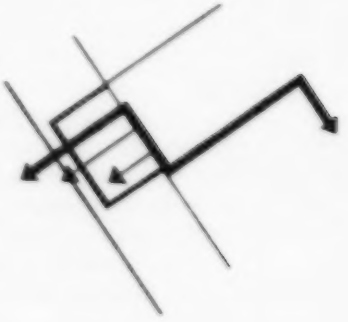
You will have noticed that the shearing forces have been shown as only acting on the joints. This is not strictly accurate as all parts of the rails taking a downward load are in shear. The joints, being cut into the legs and rails, are the weakest part of most structures and for this reason if shearing is to take place it will almost always occur at the joint.

In the chair frame shown the shearing force is trying to separate the tenons from the rails along the line of the shoulder. This force also tries to shear the glue round the tenon and force it out of position. The bottom edge of the tenon resting on the end of the mortise assists the glue in preventing this movement.



If you refer to the example of the cantilever (towel rack) it will help you to work out the forces acting on the tenon in the mortise in a situation where the chair is tipped backwards.

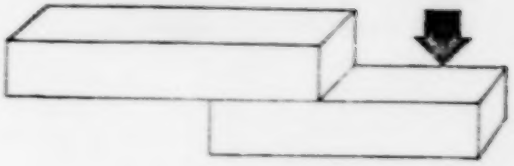
The arrows indicate tensile force, the longer the arrow the greater the force. In your opinion, at what point is the joint trying to pivot and what is resisting the tensile force trying to pull the tenon out of the mortise?



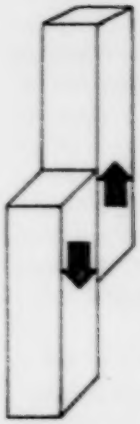
You can see that an accurately fitting joint is best. You should also be able to work out why a deep rail which allows a large tenon to be cut on it is better than a narrow one. Can you suggest what would happen if: (a) the shoulder was badly fitted (b) the sides of the tenon only touch parts of the mortise (c) the joint was starved of glue?

GLUING

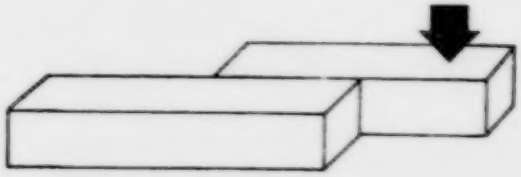
In referring to glue and gluing you will have come to some conclusions about the way in which glue works. Some simple tests will enable you to prove that glue is usually much stronger in resisting shear than in resisting a purely tensile force. Some tests are misleading in certain situations. The test shown below is not a good one as it subjects the joint to a progressive failure of the glue through bending. Joints of this sort need screws, bolts or nails to assist the glue.



Most glues give excellent resistance to a pure shearing force; a test devised on the lines shown here will be useful.



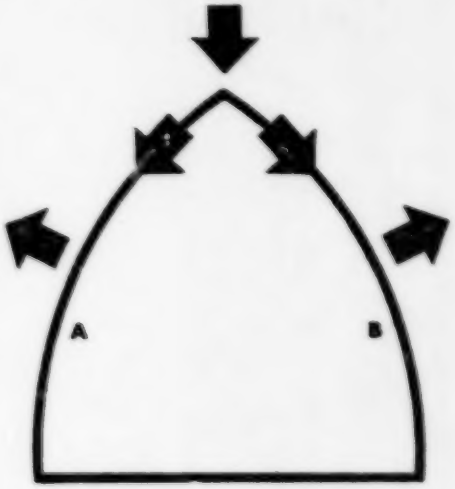
In many situations the glue will be subjected to a shearing force of the type shown where the direction and amount of force is distributed differently over the glued surfaces.
A test of this type, carried out with different glues on identically made joints, will be very useful for making comparisons between glues and the gluing properties of various materials.



FRAMES

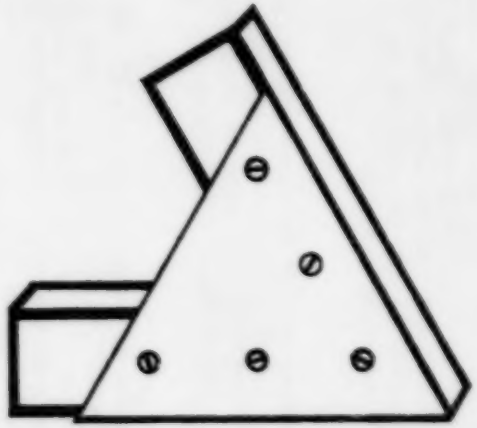
A triangular framework is rigid even if it is only held together with a simple pin or bolt at each corner.

If the members A and B of the framework shown below are deflected under a load they will eventually fail as the load increases.



A strengthened corner joint of the type shown below would increase the strength by delaying the tendency of the sides to bend under load.

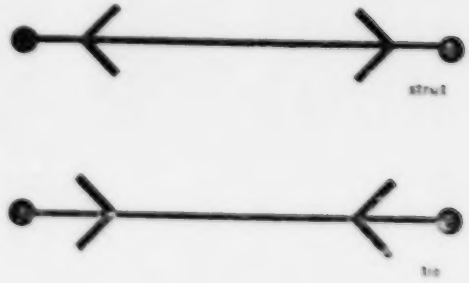
A square frame would require very strong corner joints or some other method of bracing. What alternative methods can you suggest?



A series of triangular frames can be used to construct a large girder. The great saving of weight is the major advantage of this type of construction.

The individual members must be able to withstand the forces imposed on them. A strut is shown by pointing the force arrows away from each other (tension) and a tie with them towards each other (compression).

By experimenting you can find out where the ties and struts are in such a girder. In the same way as in a solid beam, the top surface will be in compression and the bottom in tension.



5.4 One clue that can be given to students to assist them in grouping rooms is that some rooms require a quiet atmosphere. Students should realize that bedrooms will be grouped together and isolated from the noisier parts of the house. In addition, we have a second grouping (living area) which, while it does not require silence, should nevertheless be separated from the third area (work) to avoid noises created by dishwasher, power tools, etc.

After students have studied the diagram showing traffic patterns within the home, Figure 5.4 will be shown on the overhead projector to analyze why certain patterns are not advisable for the particular geographical area in which they live. For example, houses with large exterior surfaces are prone to great heat loss in the winter.

5.5 A typical arrangement of rooms is shown in Figure 5.5. The ability of students to devise their own scale and to arrange rooms will vary according to their individual abilities. Some guidance may have to be provided as to a suitable scale which produces the largest possible drawing on the squared paper provided. For example, with a building measuring 12 000 mm x 10 000 mm, a scale of 1 square equal to 250 mm would be suitable.

5.6 The most economical way to purchase styrofoam is in sheets 50 mm thick. Using a hot-wire cutter the teacher can slice walls approximately 5 mm. For the base of the house model masonite could be used. Approximately 40 pieces can be cut from one full sheet.

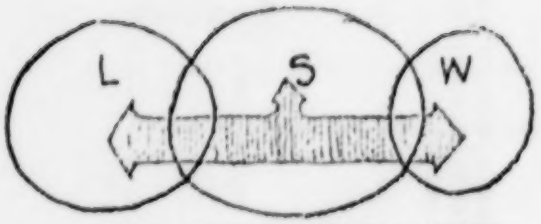
The teacher should demonstrate the use of the hot wire cutter in order that students can cut walls to length. A decision should also be made, according to the time available and the abilities of class members, whether doors and windows are to be cut out or simply marked with a pen.

Other demonstrations needed are:

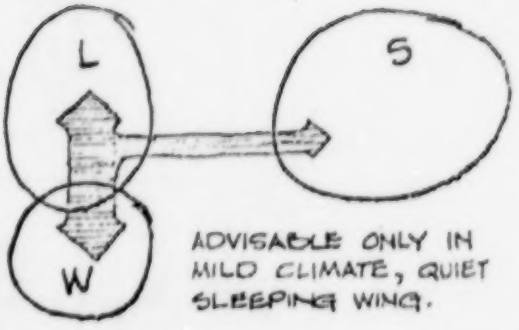
- gluing and pinning exterior walls
- marking, cutting and fitting interior walls.

5.7 Students who demonstrate superior ability or interest in model making could continue to work independently on their models. For example, they could construct the roof, decorate interiors or landscape the exterior. A useful reference document for this is the World Construction Laboratory Manual: Activities 21-29, published by McKnight and McKnight.

FIGURE 5.4



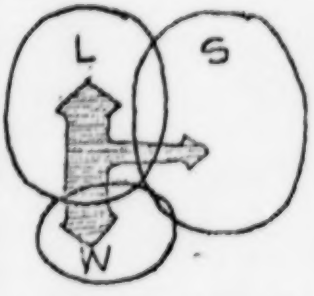
INADVISABLE, TRAFFIC LANES TOO LONG, LACK OF PRIVACY.



ADVISABLE ONLY IN MILD CLIMATE, QUIET SLEEPING WING.

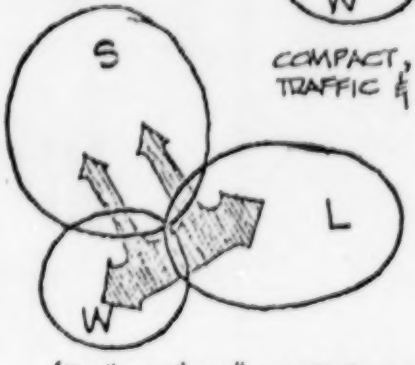
RAMBLING, INADVISABLE IN COLD, WINDY CLIMATE.

ENTRANCE SYMBOL



COMPACT, EFFICIENT TRAFFIC & HEATING

RAMBLING, VARIATION OF ABOVE



"ELL" OR "TEE" SHAPED, EFFICIENT TRAFFIC, CAN PROVIDE PROTECTED PATIO

VARIATION OF ABOVE, SEPARATE SLEEPING WING FOR GUESTS, RENTAL, ETC..

NOTES:

1. S = SLEEPING, L = LIVING, W = WORKING AREA
2. WIDTH OF ARROWS INDICATE RELATIVE AMOUNT OF TRAFFIC
3. ANY SCHEME MAY BE VARIED BY PLACING ANY OF THE AREAS ON ANOTHER LEVEL.

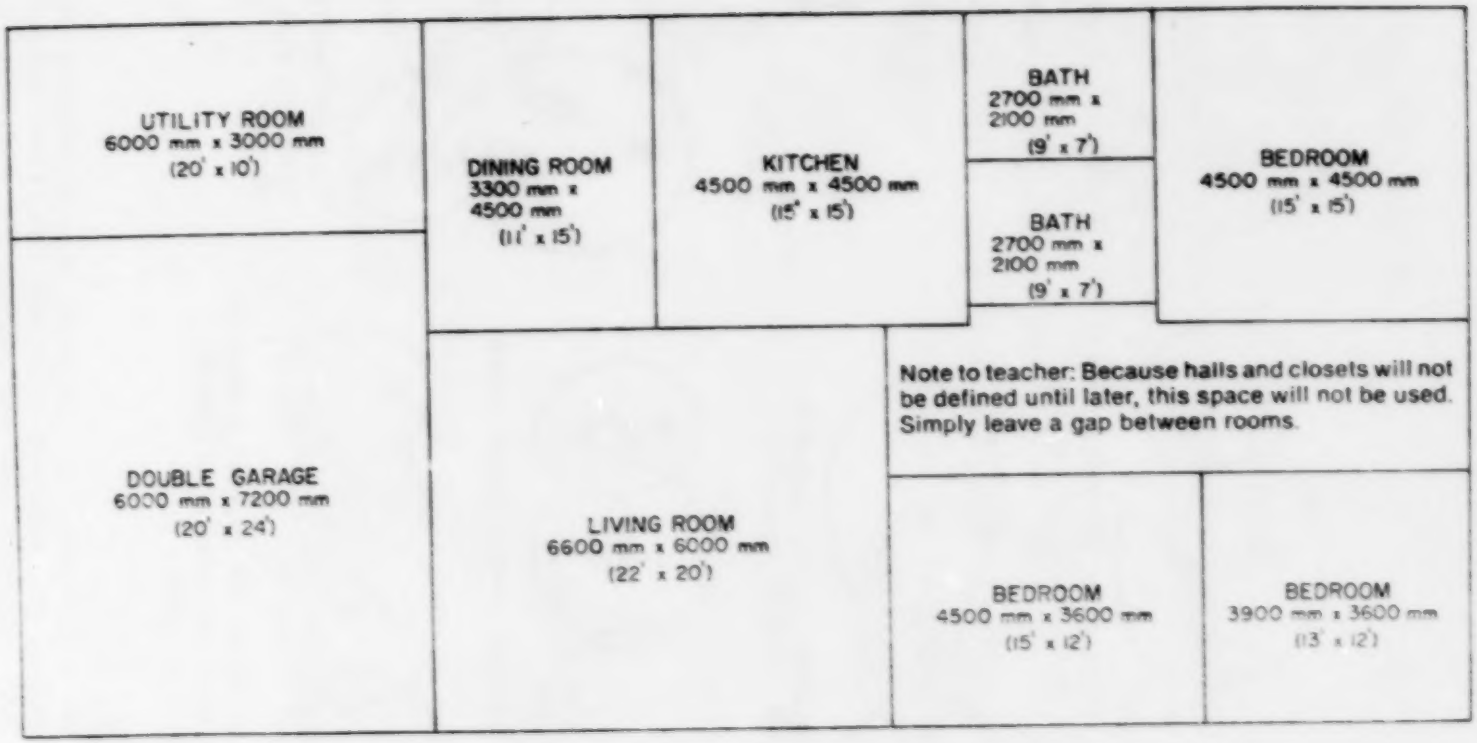


FIGURE 5.5 *Typical room arrangement*

6.0 SIMPLE MACHINES--Objectives

Students will be able to

- Identify different types of simple machines
- State where these simple machines exist in everyday objects
- List advantages of simple machines
- Identify the three classes of levers
- Discover uses of the inclined plane as a means of reducing effort
- Raise a heavy weight by designing a system of pulleys
- Design and build gear trains to alter speed and change direction of rotation

6.0 SIMPLE MACHINES--Teacher Guide

6.1 Show slides (17-40) to students and read the text below which explains each slide.

11 Using an old door as a ramp, one of the boys pushes the wheelbarrow up to the yard. A ramp is a simple machine called an inclined plane. A "plane" means a flat surface, and "inclined" means sloping.

12 A teen-ager pushes his motorcycle up a ramp toward the back of a van. The inclined plane helps support the weight of the motorcycle. It takes less force to push the motorcycle up a ramp than it does to lift the cycle straight up.

13 A longer board gives a more gradual slope. The more gradual the slope, the less force is needed to push the motorcycle up the inclined plane.

16 When a stairway winds around in a spiral, it forms a second type of simple machine called a screw. A screw changes a circular motion into

17 Sometimes the screw itself goes around. The close-up shows the kind of screw that holds things together. A carpenter uses such a screw to join two pieces of wood. As he twists the screw in a circular motion, it goes down into the wood.

18 A workman pulls a handle that turns another kind of screw known as a jackscrew. It helps lift very heavy objects, such as part of a building. The jackscrew increases the force so that one man's effort can lift many tons.

20 A wedge is a third type of simple machine. This metal wedge can help split the big log. The narrow end enters the wood first. As the wider part goes in, it forces the log apart.

21 A boy has just struck the wedge, pounding it into the log. The shape of the wedge increases the force of the boy's pounding. A wedge also changes the direction of the force. The downward force of the pounding is changed to a sideways force that splits the log.

22 Have you ever thought of a sewing needle as a machine? A needle is another wedge. The sharp, narrow point spreads apart the fibers in a piece of material. Then the wide part of the needle and the thread can be drawn through the fabric.

27 A boy presses down on a board to lift a heavy log. The board rests on a stack of bricks. Used this way, the board and the bricks make a lever.

28 Although used for play, a seesaw is really a lever. The long board is known as the lever arm. The board rests on a fixed support called the fulcrum. With the fulcrum in the middle, two boys of equal weight sit balanced on the lever arm.

29 When the fulcrum is moved closer to one end of the board, one boy can lift two others. The weight of the one boy provides the force to move the lever arm. The weight to be lifted – his two friends – is called the resistance.

30 Every lever has a force, a fulcrum, and a resistance. A girl uses a claw hammer as a lever to remove a nail. Her muscles supply the force on the handle. The place where the hammerhead touches the board is the fulcrum. The nail is the resistance.

31 A bottle opener is another type of lever. The force of the boy's muscles lifts up on the handle. The fulcrum is the end of the opener that presses down on the bottle cap. The resistance is the edge of the cap that will be lifted up by the opener.

6 The girl easily cracks the walnut with a nutcracker, a simple machine. She uses the force of her muscles to squeeze the nutcracker. A force must always be used to make a machine do work. A simple machine cannot create a force, but it does make work easier.

33 A pulley is another simple machine. Each of these two pulleys has a wheel with a groove that holds a rope.

35 A pulley also helps lift heavy objects. An engineer struggles to raise a piece of machinery called a valve. His friend keeps the valve from bumping into the cabinet. Only one strand of rope supports the weight of the valve, so the engineer has to pull down with a force equal to the weight of the valve.

36 In this system of two pulleys, sometimes called a block and tackle, the weight of the valve is divided between two strands of rope. Now the engineer has to pull only half as hard as before, but he has to pull the rope twice as far. This pulley system increases the force.

41 Sometimes a wheel and axle turns another wheel. A bicycle pedal is attached to a wheel with teeth, called a gear wheel. The teeth of the gear wheel fit into links of a chain. As the pedals make the gear wheel go around, the chain moves . . .

42 . . . and turns another gear wheel in the center of the big rear wheel. This big wheel makes the bike move forward.

43 The face of this clock has been removed to show some gear wheels inside. The teeth of the gear wheels fit directly into each other, so that when one gear wheel goes around, they all turn. As these gear wheels go around, they turn the hands of the clock.

44 On an eggbeater, the large gear wheel fits directly into two smaller gear wheels that turn the beaters. Each time the handle turns the large wheel around once, the smaller gear wheels go around five times. The gears of the eggbeater increase the speed, since the beaters turn five times faster than the handle does.

45 An eggbeater also changes the direction of the force. The boy turns the handle in an up-and-down circle. The beaters go around in a horizontal motion to mix the cake batter in the bowl.

46 A girl uses a hand drill, a complex machine. A complex machine is made up of two or more simple machines. The crank handle works as a wheel-and-axle machine that turns the gear wheels. The drill itself is a screw, and the sharp drill point is a wedge.

The above materials are taken from the following film strip series.

SIMPLE MACHINES: National Geographic Society, Washington, 1981.

Examples of things which could be listed by the students on their charts are:

- pulley systems in venetian blinds
- electric switches
- door mechanisms
- hockey stick
- hammer
- nut crackers

The teacher should make an overhead transparency of the chart and when students have completed their charts the teacher should ask class members for examples. Fill in the chart and afterwards discuss whether the assessment of which simple machines are incorporated in particular devices is correct or not. Finally, reinforce the idea that all complex machines involve several simple machines.

Some of the advantages of simple machines which could be listed are:

- changing the direction of a force
- increasing the amount of force that can be applied
- reducing the force that is applied
- applying a force to a place that cannot otherwise be reached
- applying a force in ways that cannot be done without machines

6.2 The teacher should make a transparency in order to explain the three classes of levers as shown below. Background material is included on the following pages.

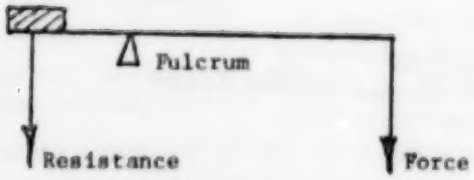
CLASS 1

Seesaw

Scales

Scissors

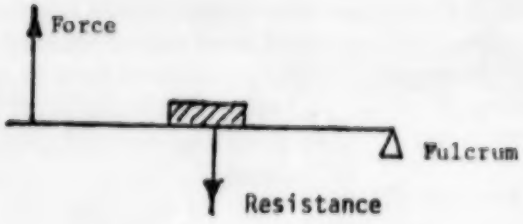
Crow Bar



CLASS 2

Nut Crackers

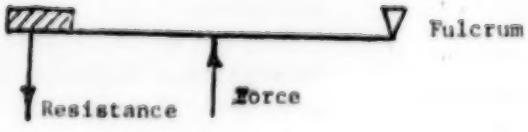
Bottle Opener



CLASS 3

Coal Tongs

Sugar Tongs



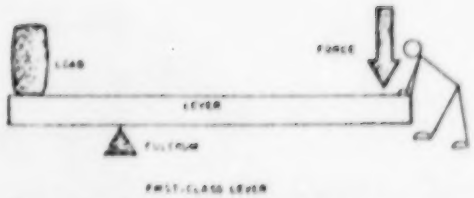


Figure 1–10 The first-class lever has the fulcrum placed between the point of effort and the load.

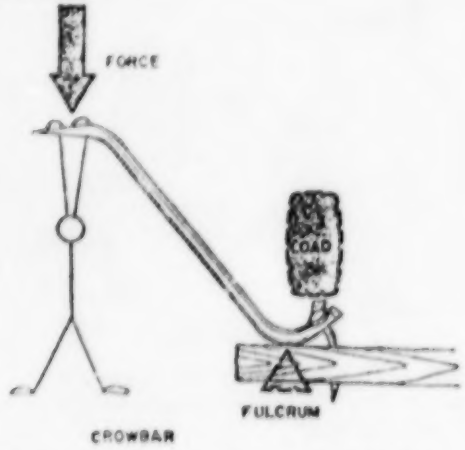


Figure 1–11 The crowbar is a form of first-class lever.

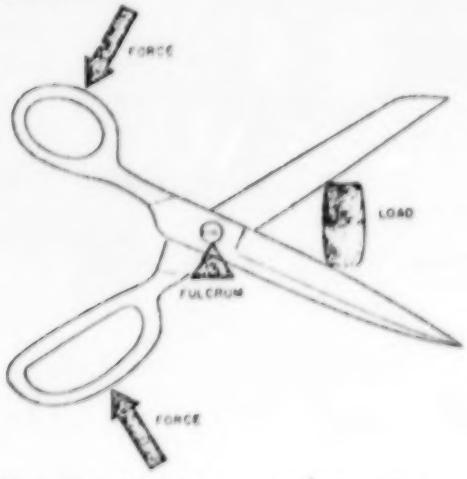


Figure 1–12 Scissors consist of two first-class levers sharing a single fulcrum.

The Lever

A Greek scientist named Archimedes (287-212 B.C.) knew how to use simple machines such as the lever, revolving screw, and pulley. He once boasted, "Give me a place to stand, and a lever long enough, and I will move the world." We use many kinds of levers in our lives to make jobs easier.

Basically, a lever is a long beam. It rests on a pivot point called a *fulcrum*. The position of the load to be moved is called the *point of resistance*. The place where force is applied is called the *point of effort*. How much effort must be applied to move a given load depends upon where the fulcrum is located.

Types of Levers. There are three types of levers. They have different load, effort, and fulcrum positions and are known as first, second, and third-class levers. Each type has special advantages.

In *first-class levers* (**Fig. 1–10**), the fulcrum is placed between the point of effort and the load. The work performed moves in a direction opposite to the effort applied. Examples of first-class levers are seesaws, crowbars, pliers, and scissors (**Figs. 1–11 and 1–12**). Items like pliers and scissors consist of two levers sharing a single fulcrum or pivot point.

Second-class levers always have the load placed between the point of effort (force) and the fulcrum, as shown in **Figure 1–13**. In this case, the work

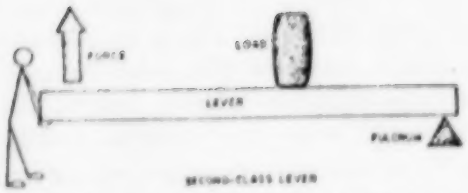


Figure 1–13 The second-class lever has the load placed between the point of effort and the fulcrum.

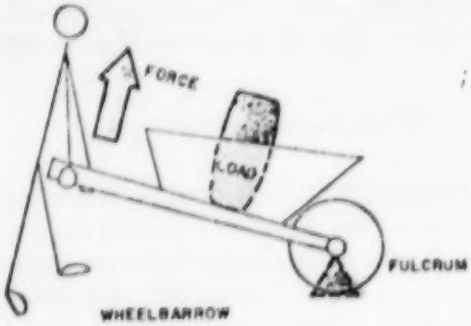


Figure 1–14 A wheelbarrow is an application of the second-class lever principle.

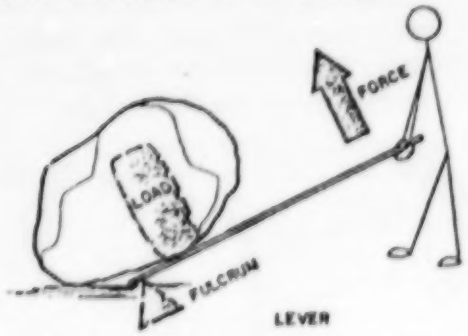


Figure 1–15 This pry bar is a second-class lever.

done moves in the same direction as the effort applied. A wheelbarrow, a nutcracker, and a pry bar are examples of second-class levers (**Figs. 1–14 and 1–15**).

In *third-class levers* the force (effort) is applied between the load and the fulcrum, as shown in **Figure 1–16**. Once again, the work performed and the effort applied move in the same direction. Some examples of third-class levers are brooms, hammers, and baseball bats (**Figs. 1–17 and 1–18**).

Mechanical Advantage. All forms of levers are designed to give at least some *mechanical advantage*. This is simply the relationship between the load and the effort applied, expressed as a ratio (for example, 2:1). It can also be thought of as *force multiplication:* you are able to move a heavier object with less effort.

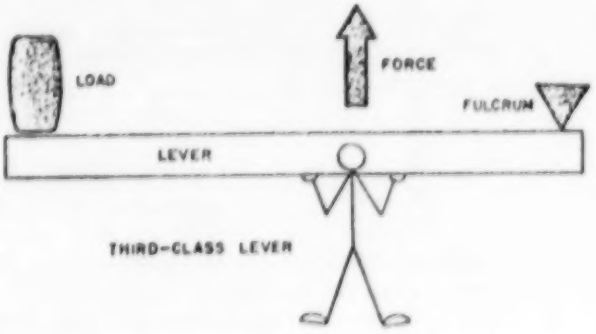


Figure 1–16 The third-class lever has the effort exerted between the load and the fulcrum.

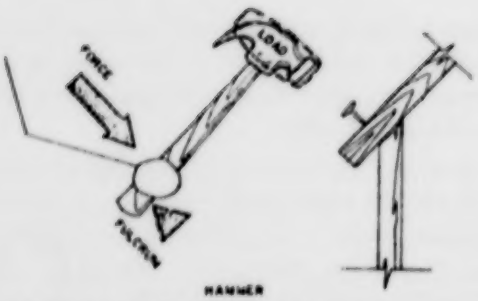


Figure 1–17 The hammer is a third-class lever.

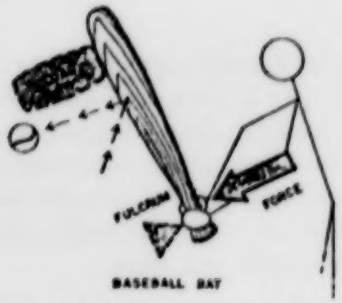


Figure 1–18 A baseball bat is another application of the third-class lever principle.

Figure 1–19 It takes less effort to lift a load when the fulcrum is placed close to the load. But, in this situation, the load moves only a short distance.

Figure 1–20 When the fulcrum is placed closer to the point of *effort*, it takes greater force to move the load. The load, however, moves a greater distance.

The mechanical advantage gained can be increased or decreased. This is done by changing the position of either the fulcrum or the load. The effort required becomes less as the fulcrum and load are brought closer together (**Fig. 1–19**). *Increasing* the mechanical advantage will *reduce* the rate of work (distance that the load is moved). If an increase in the *work rate* is desired, then the fulcrum must be closer to the point of *effort*. This will decrease the mechanical advantage, but will move the object a greater distance (**Fig. 1–20**).

The Wheel and Axle

This simple machine consists of a circular object fixed to a shaft. A good example is the automobile steering wheel. The driver's effort is multiplied so that the car can be turned with very little effort. The mechanical advantage gained is based on the principle of the first-class lever (**Fig. 1–21**).

The wheel and axle has many uses. Sometimes, it is used to gain mechanical advantage; in other applications, it is used to increase speed. There are many kinds of wheels for different types of work.

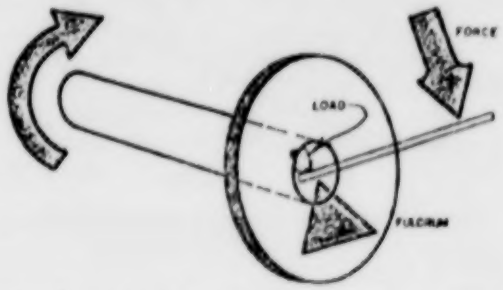


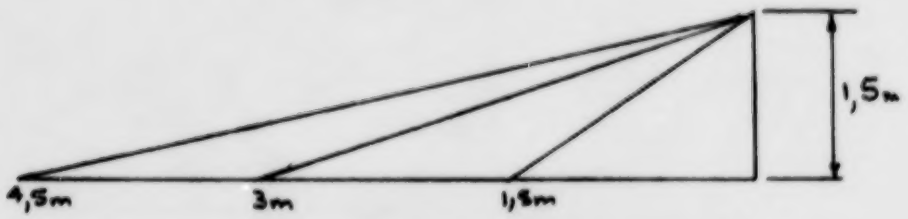
Figure 1–21 The wheel and axle is a form of first-class lever.

Answers to students questions on levers

Question No.	Class of Lever
1	1
2	2
3	1
4	3
5	2
6	2
7	2
8	3
9	1
10	3

6.3 Present a drawing of a situation where a barrel has to be raised 1,5 metres. (This could be a piano or a motorcycle.) Students can be asked to draw solutions in their books or on the blackboard.

After students have completed their sketches the teacher should compare the various slopes to determine advantages and disadvantages and to decide on the optimum slope. To do this a transparency of metric squared paper should be used. Draw various solutions which the students should provide: an example is shown below.



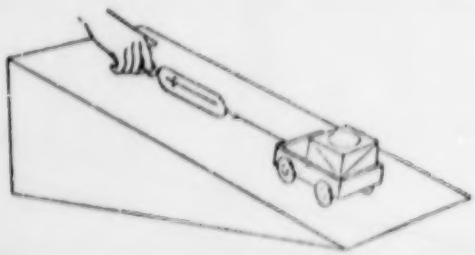
Students should be led to understand that it will be difficult to push the weight up a short steep slope and very easy, although time consuming to push it up a long shallow slope. The length of slope needed for a particular task depends on the weight of the object (i.e.) a very heavy object requires a longer slope. To calculate the force necessary to push this weight up the slope the following formula should be used:

$$\text{Force Required} = \text{Load} \times \frac{\text{Vertical Height}}{\text{Length of slope}}$$

After calculating several examples, students will realize that a slope of 3 m is sufficient because the force would be only 25 kg. (A slope of 6.0 m would reduce the force to 12,5 kg . However, this slope would be too long except for a relatively weak person.)

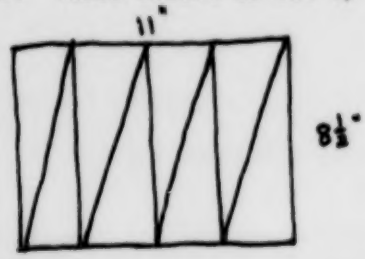
NOTE: An alternative methods of illustrating this concept is shown below. Several slopes should be used to calculate different forces required for different slopes.

Materials: A board or plank several feet long
A support for one end of the board (Books, large blocks, or a chair will do.)
A toy cart or truck that rolls easily
Spring scale
String
Measuring tape or stick

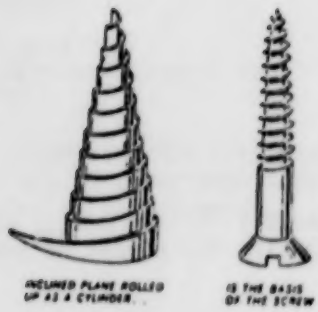


How much force is needed to pull a cart and a weight up an inclined plane at a constant velocity?

For the next exercise students are required to roll triangular strips of paper into cylinders. These should be cut up as shown below.

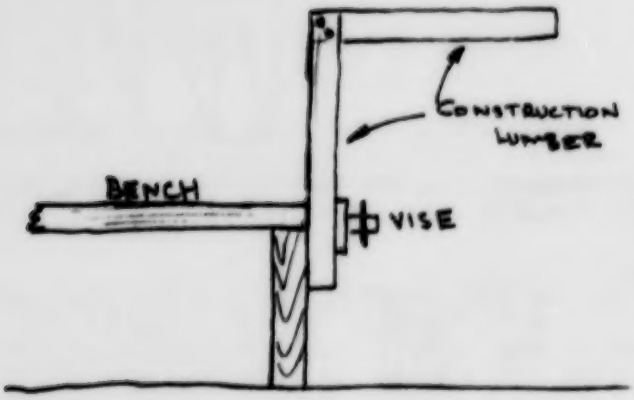


Students will see from the spiral shape that they have formed a screw thread.



Screw is an inclined plane wrapped into form of a cylinder.

6.4 Pulleys



The apparatus necessary for the pulley experiments can be simply constructed by mounting two pieces of construction lumber as shown above.

Materials for each student are:

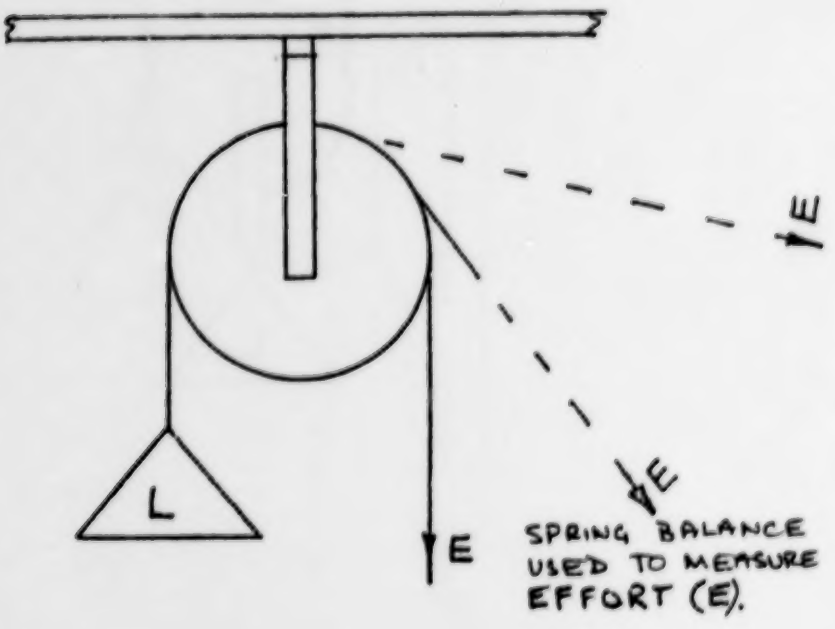
3 small pulleys
2 pieces of rope: 1 x 3 m, 1 x 2 m
3 hooks
2 pieces of construction lumber
2 bolts (to fasten lumber)
1 weight (e.g.) of at least 5 kg with a hook attached
1 spring scale

Teacher should ask the student to lift the weight and would point out while this is a small weight and could be lifted, sometimes we have weights which are too heavy for one person to lift. Ask for examples from the students (examples are engine block, machinery, pallets of bricks or sod).

To bend over and lift a heavy object is harder than pulling downwards so one way to make this job easier is to throw a rope over the beam and pull downwards. Students will realize that there is considerable friction between the rope and the beam. Ask how this can be reduced. Examples of replies will be

- grease the rope
- run the rope over a smooth hook
- use a pulley

Friction is still a problem with the first two examples so the pulley is the preferred solution. Teacher should set up a single pulley system and ask student to raise the weight.



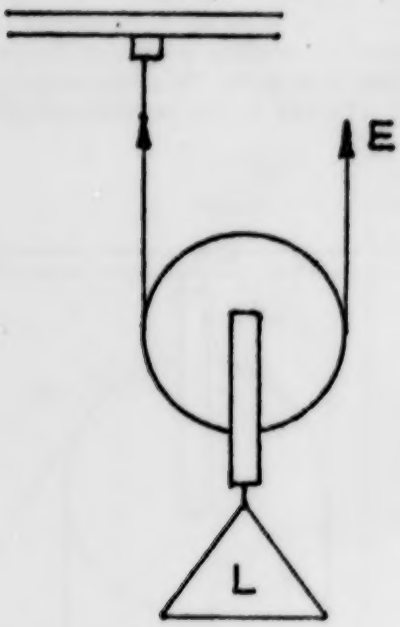
Some points that the students should now consider are:

- which is the optimum direction in which to pull: down or up?

- is the effort required to raise the object less than, the same or greater than, the weight of the object (the answer to this can be verified by use of the spring balance)

It will be noted that the effort is still approximately equal to the weight of the object. The only advantage is that you are pulling down on a rope instead of bending over in a position which is bad for the spine.

Have students imagine that the weight is too heavy to lift by pulling on the rope. We need to increase the mechanical advantage. Teacher should now set up pulley as shown below.

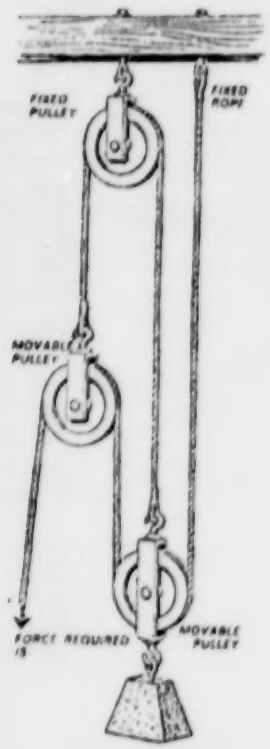


Using the spring balance check the effort required to raise the load. Students will note that the effort has been approximately halved. Ask:

- what conclusion can be drawn from this (the mechanical advantage is approximately equal to the number of supporting strands)
- what problem exists with this system (we are pulling upwards)
- how can this problem be avoided (by using another pulley so that the rope is pulled down)

The class should work either individually or in pairs to set up a two pulley system and verify the effort needed to lift the weight by using the spring balance. Each student should record in diagrammatic form, on squared paper, the pulley system they devised. In addition, they should record the weight of the object and the effort required to lift it.

The teacher should assemble the class and make comparisons between the various different pulley systems devised by the students. The question now posed to the students is "Can we further reduce the effort needed to raise the weight?" Students should use the materials in listed at the beginning of Section 6.4 to attempt to solve this problem by devising a three-pulley system. Once again students should record their solution as was done for the two-pulley system. One possible solution is shown below



6.5 GEARS - Teacher Guide

The parts used to construct the gear systems kit are available by special order from FISCHER TECHNIK.

	DESCRIPTION	PART #
1	Base Plate 180x90	4-31001-1
1	Gear Wheel Z40/32	4-31022-1
1	Gear Wheel Z30	4-36264-1
4	Flat Hub	3-31015-1
1	Building Block 30	3-31003-1
1	Building Block 30 with Bore	3-31004-1
1	Building Block 15	3-31005-1
2	Tire 45	4-31018-1
6	Axle 50	4-31033-3

It is vital that the teacher construct containers for individual kits as described above. These kits should be assembled in such a way that they can be easily checked and missing parts readily identified.

It is anticipated that students will work through this unit without help from the teacher.

ANSWERS TO QUESTIONS

Question No.

4	30 : 20 3 : 2
6	Change of direction increase in speed (i.e. for every two revolution of the large gear the small one revolves three times)
7	3 : 2 (Ratio) 2 : 3 (Revolutions) The two sets of numbers are the same except that the ratio is the inverse of the number of revolutions.
8	(a) 3 revolutions (b) 4 revolutions
9	(a) 3 : 1 (b) 4 : 1
10	The right gear wheel rotates 1/3 of a revolution
11	1 : 3
12	Examples are bicycle, clock, gear box, spinning reel, metal lathe
15	The direction of rotation is reversed
16	The gears are at right angles to each other
17	Differential for automobile

7.0 ENERGY RESOURCES--Objectives

Student will be able to

- Understand their dependency on electrical power
- List the various sources and forms of energy
- Investigate the harnessing and use of one form of energy
- Construct a model to demonstrate harnessing or use of energy

7.0 ENERGY RESOURCES--Teacher Guide

7.1 To set the stage for this theme the teacher should organize the room so that one or more entertainment devices are playing in the room (T.V., projector, video game, etc.). At the point where students are thoroughly interested in the apparatus arrange for the power to be mysteriously cut off. Allow students to react freely and ask them for their thoughts concerning what had happened. Find out if students have experienced black outs in the past and what they were doing at the time the power failure happened. List the devices mentioned (see Figure 7.1).

This work is followed by a student exercise as listed in their texts. If this work is not completed by the end of the period it should be finished at home prior to the next class session.

7.2 The teacher can refer to the exercise completed at home and discuss the fact that so far only one form of energy has been discussed. This should lead on to a discussion of sources and forms of energy. Ideas suggested by the students can be used to construct a list as shown below.

Source of Energy	Useable Form
1. Fossil Fuels - coal	processed coal
- crude oil	refined oil
- gas	natural gas
2. Nuclear Energy	electricity
3. Geothermal	direct heat
4. Solar	direct heat or electricity
5. Wind and Wave	electricity or mechanical
6. Hydro and Tidal	water wheel or electricity

The teacher should present basic information about each of these sources and forms once they have been identified.

7.3 The teacher should develop "resource packs" of information for each of the six sources of energy above. After a brief discussion of each source students should choose one of the six to investigate. This will mean a team of approximately three students for each source of energy.

7.4 Previously the students examined one source of energy and how it was converted to a usable form. The next project is for students to construct a model to illustrate either:

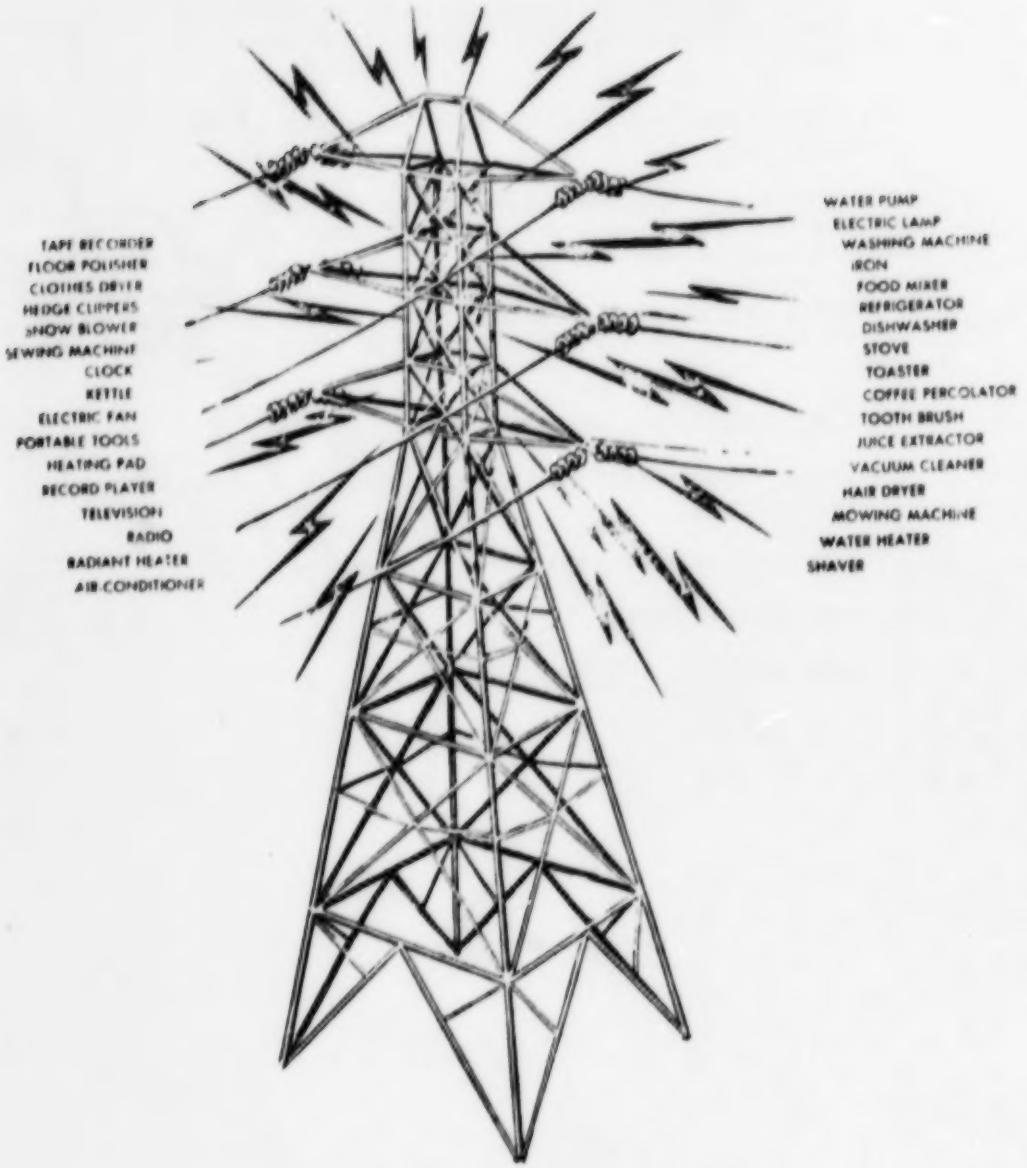
- how the source of energy is extracted or harnessed

OR

- how the energy form is used

Students will discover many possible ideas, just a few are attached. See Figures 7.4.1 to 7.4.8

Figure 7.1



Uses of electricity

Steps in producing the model are:

- show by means of overhead projector or photographs examples of models which other people have made

- supply students with resource books and materials from which they can find information on models to build

- require that the students submit a sketch of the model they wish to make

It is preferable if students select their own model. You may supply some basic materials (wood, threaded rod, sheet metal, etc.) but students should be expected to find unusual shaped items themselves possibly from waste or recycled products. In some cases students will require considerable guidance and assistance and occasionally it may be necessary to provide a drawing of the model which should be made.

7.5 Optional activity. Some examples are:

- energy conservation in the home (insulation, heat pumps, solar energy)

- cars (use of more energy-efficient engines)

- wood burning stoves

- mass transit

AVIATION - AEROSPACE

ROCKETRY

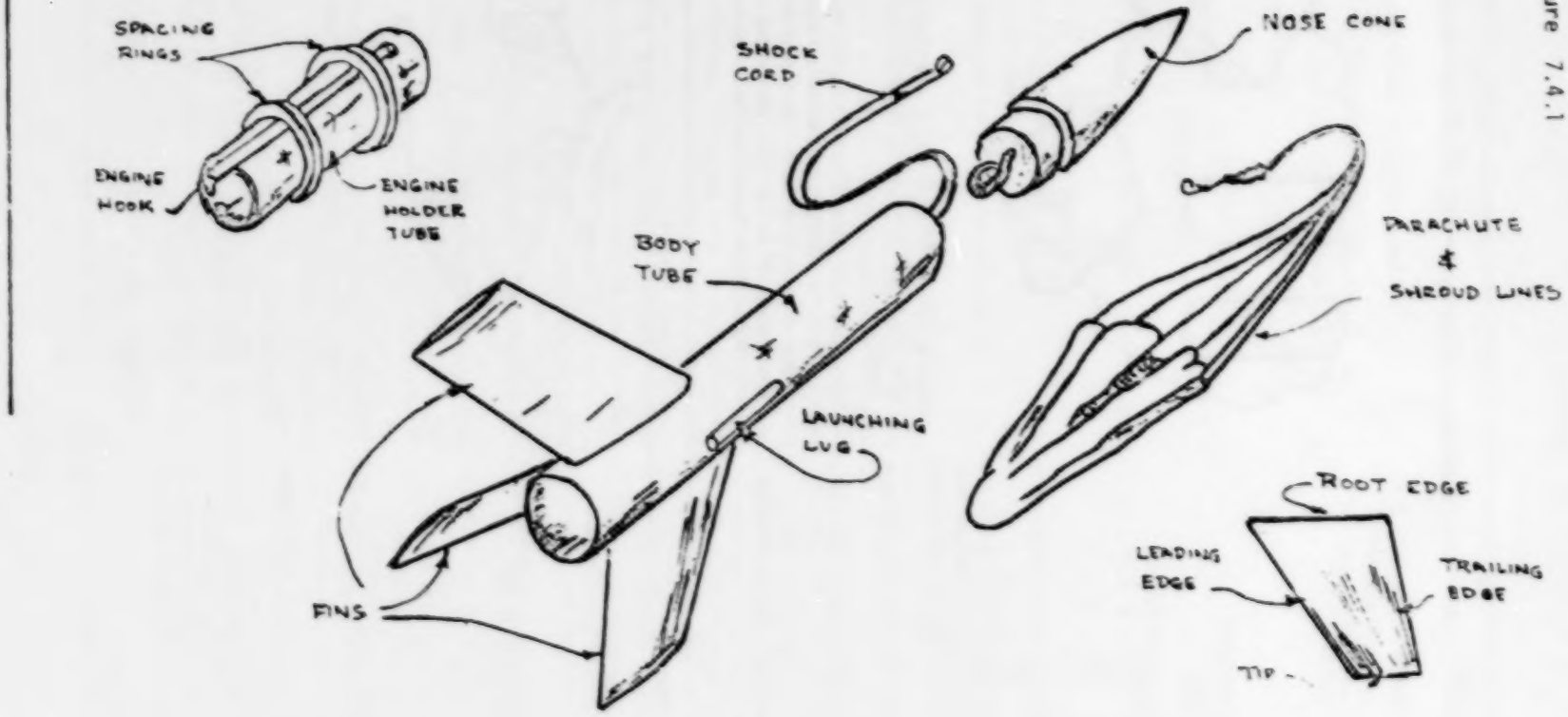


Figure 7.4.1

IDEA/PROBLEM

Everyone on earth is influenced by man's remarkable achievements in the air and in space. Meaningful learning experiences in which students actually build, launch and safely recover their rockets provides a realistic opportunity for students to apply theoretical learnings.

Figure 7.4.2

activity

General Area: Cultural Environment

Specific Area: Electricity

Problem: How does a fuse work?

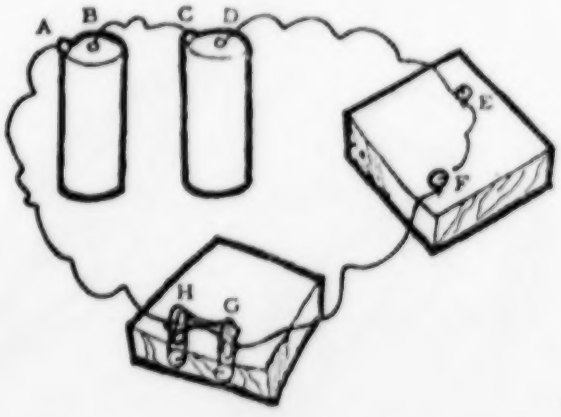
Grade Level: Upper

Materials:

1. Two dry cells (No. 6 preferable)
2. Four feet of insulated wire
3. Six strips of tin foil
4. Two paper clips and four thumb tacks
5. Two pieces of wood 4" x 4" or 8" x 4"
6. Knife switch

Procedure:

1. Connect the two dry cells in series as shown in sketch.
2. Put in thumb tacks and paper clips to side of block so that paper clips are in upright position.
3. Connect one wire from dry cell to one thumb tack.
4. Connect another piece of wire from second tack to knife-switch.
5. Connect last wire from knife-switch to other dry cell.
6. Open knife-switch.
7. Put small strip of foil between the paper clips.
8. Close knife-switch.



Results: When points E and F are touched with wire the "fuse" will blow out if the foil is a small enough piece.

Supplemental Information: When the fuse blows out, it will show the students the value of fuses as safety features in their homes. It should be stressed to exert care when touching the wires connected to the dry cells, as these sometimes tend to get hot.

activity

General Area: Cultural Environment

Specific Area: Electricity

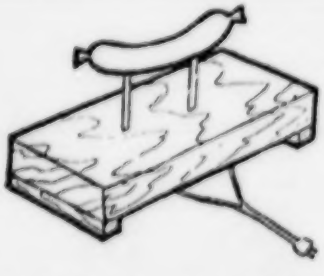
Problem: How does electricity work for us?

Grade Level: Intermediate

1. "Hot Dog"
2. Two nails
3. Block of wood
4. Electric cord (at one end connected to both nails)

Procedure:

1. Nail the two small pieces of wood to the large block as shown in sketch.
2. Drive two nails through the large block. Leave about ¼" of head at the bottom of the block.
3. Wire the ends of each wire around the head of each nail and drive nail into the block to hold the wires securely.
4. Impale the "hot dog" on the nails.
5. Plug the end into an electric outlet.
6. Observe results.



Results: "Hot Dog" acts as a conductor of electricity. It becomes hot and begins to sag and swell. Hot dog is cooked.

Supplemental Information:

1. Hot dog is a conductor of electricity.
2. Some conductors produce heat.
3. Electrical energy is converted to heat energy in this demonstration.
4. Safety note: Be sure that the electric cord is well insulated and that it is not plugged into the outlet before the wires are attached to the nails.

Figure 7.4.3

activity

General Area: Cultural Environment

Specific Area: Electricity

Problem: How does an electric motor work?

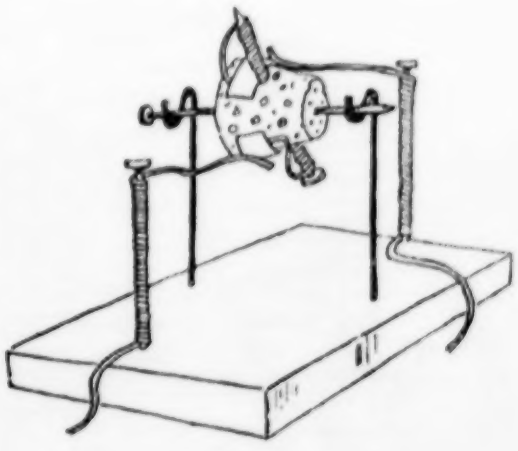
Grade Level: Upper

Materials:

1. Wire coat hanger
2. 60 ft. very fine insulated wire
3. Large cork
4. Metal contact points (may be cut from a food can)
5. Three — 10/penney nails
6. Twelve — penney nails
7. Board for base
8. Two batteries or six volt transformer

Procedure:

1. Make the armature. (See inset). The 10/penney nail is pushed through the center of the cork and will act as bearings on which the armature will turn. The 12/penney nail is inserted through the cork in the opposite direction. It must be balanced and mounted in such a manner that it will allow the cork to rotate freely. This nail is wrapped with 20 feet of small gage insulated wire. Wrapping must be in **same** direction (clockwise) on both sides of cork. Bare ends of wire are attached to contact points (A) on opposite side of the cork. Armature contact points should be made of metal and attached firmly to cork (see end view of armature).
2. The mounts for the armature are made by bending 2 pieces of metal coat hanger in such a manner that they will support the armature (see diagram).
3. The "field" is made by driving two nails into the block so that when the armature turns, the ends of the wrapped nail on the armature will just miss the heads of the nails driven into the block. These nails are then wound with 15 ft. of small gage, insulated wire on each nail, clockwise from bottom to top of nail. The ends of the wire are bent to make contact on opposite sides of the armature.
   (Insulation is scraped off ends to make contact points.)
4. Set the armature on the mounts and balance it so it will rotate freely.
5. Adjust the ends of the field wires so that they contact armature "contact points."
6. Turn on the current.



Results: The electric current flowing through the wire which is wrapped around the nail sets up a magnetic field. The metal points on the armature coming in contact with the bare wire points on the field allow the current to flow through the armature also. This in turn sets up a magnetic field around the nail which is the part of the armature. As this armature rotates, the poles of the magnetic field are reversed. This causes the like poles to be adjacent to each other. Like poles repel each other and the motor runs.

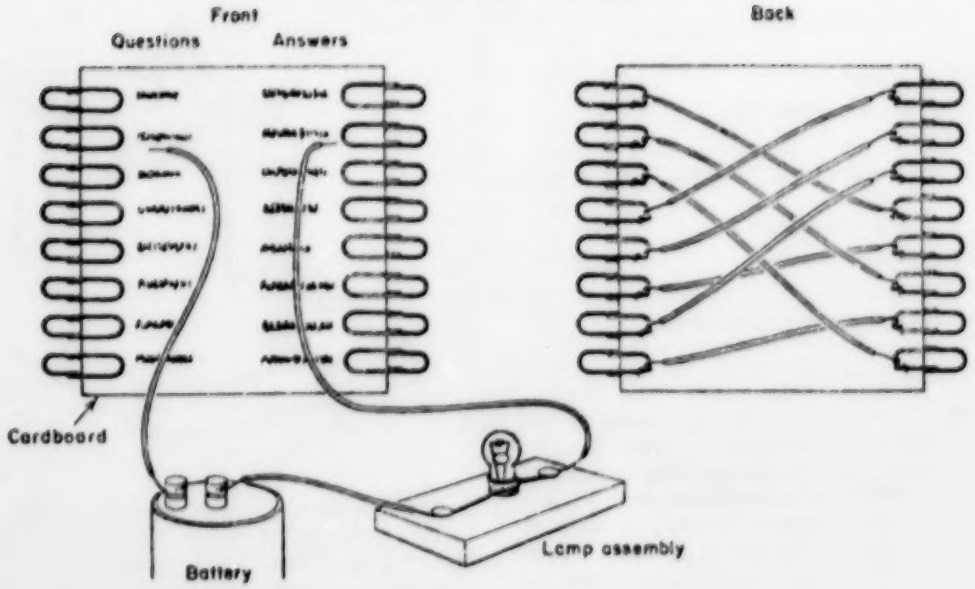
Supplemental Information: The wiring of the field and armature is done in a manner which makes it impossible for unlike (North and South) Poles to come near to each other. In other words, when the end of the **armature** is adjacent to the top of the **field** nail which has a North pole charge, the current is flowing in a direction which cause this end of the armature to be a North pole also. Like poles repel each other, therefore the motor rotates.

The important items in making this motor work are:

1. The armature must rotate very freely.
2. The contact points on the armature must be adjusted so the wire brush points from the field contact them at exactly the time they are opposite the nail head on the field.

Figure 7.4.4

GAME 4. QUIZ GAME



Two wires for connecting chosen answers to questions. If you are correct the bulb lights.

Figure 7.4.5

HOW TO MAKE A MODEL RAILROAD SIGNAL

To make this project you will need:

PART	NO. REQ.	SIZE	MATERIAL
Base	1	1/2" × 3" × 4"	basswood
Post	1	1/2" dia × 8"	dowel
Signal arm	1	1-1/4" × 3"	tin plate
Signal arm weight	1	1" × 1", 24 ga	copper
Woodscrews	3	No. 6 × 1/2" round-head	brass
Clips	2	3/4" fahnenstock	
Solenoid	1	as in Fig. 3.51	
Iron core	1	3/16" dia × 2"	soft iron
Hook-up wire	2	5" long	stranded copper

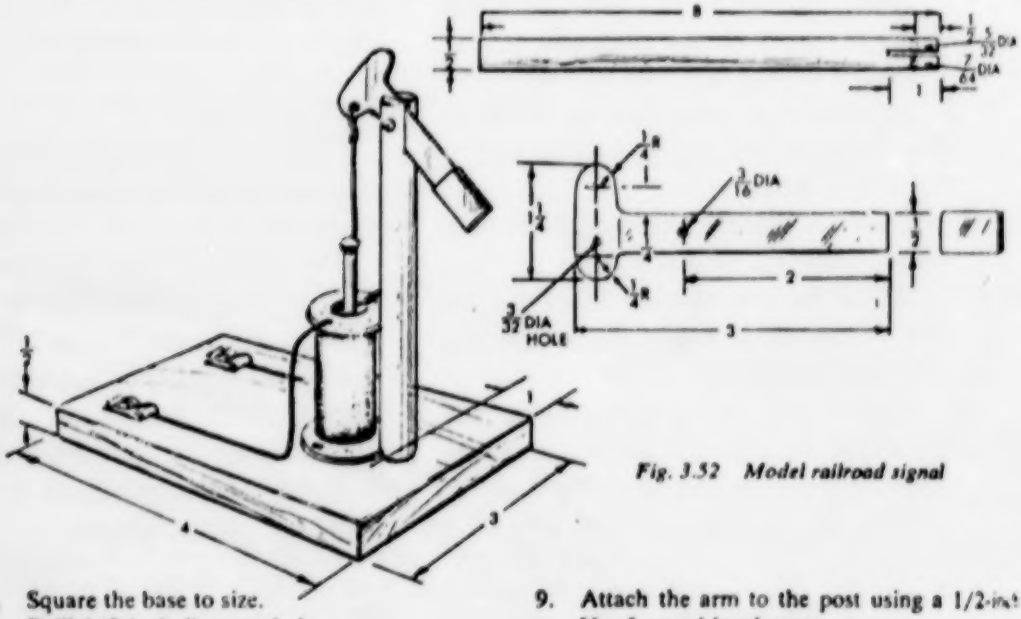


Fig. 3.52 Model railroad signal

1. Square the base to size.
2. Drill 1/2-inch diameter hole.
3. Cut 1/2-inch dowel to length, and make a saw cut 1 inch deep with a back saw.
4. Drill pilot hole and clearance holes through the dowel.
5. Make the solenoid as shown in Fig. 3.51.
6. Lay out and cut out the signal arm.
7. Drill holes in the arm.
8. Fold copper and solder it to the signal arm.
9. Attach the arm to the post using a 1/2-inch No. 6 round-head screw.
10. Glue the post in the hole drilled in the base
11. Glue the solenoid to the base as shown in the drawing.
12. Suspend a 2-inch piece of iron with thread from the signal arm (a 3-inch common nail with the pointed end cut off to make it the required length is suitable). The iron should be hung so that it is just entering the solenoid

Figure 7.4.6

HOW CAN WE MAKE A TELEGRAPH SET?

You will use:
- Dry cell
- Wire
- Switch
- Two nails
- Screw
- Piece of metal
- Block of wood

Do this:

Bend the piece of metal into the Z-shape shown in the diagram.

Nail it on the block of wood.

Hammer two nails into the wood so that they are just under the free end of the metal strip.

Connect a fairly long length of wire to one terminal of a dry cell.

Wind the wire several times around one of the nails, beginning at the top and working down.

Then bring the wire across to the other nail and wind it around as many times as the other one, working upward.

Connect the other end of this wire to one terminal of your switch.

Connect a second wire between the free terminal of the dry cell and the switch.

Close the switch. The sounder — the Z-shaped metal — will be attracted to the two nails underneath it.

You may have to adjust the sounder before it will work.

You have now made a simple telegraph sounder — and found a practical use for your electromagnet.

Why it works:

Electricity flowing through the coils of wire around the nails made the nails magnetic.

The sounder was attracted to the nails as long as electricity was flowing through the circuit.

The famous American inventor Samuel F. B. Morse, in 1844, made it possible to communicate with people in distant places by signals through the means of the telegraph.

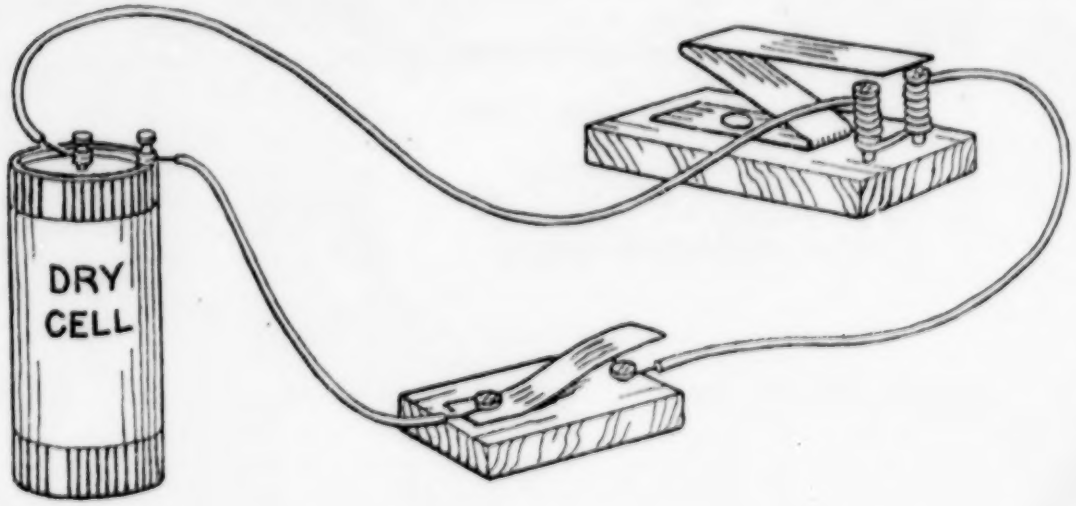


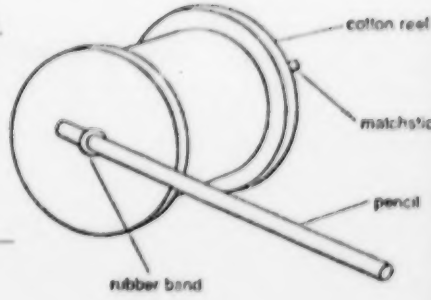
Figure 7.4.7

Simple Energy-using Machines

A Simple Cotton Reel/Rubber Band Motor

Equipment required: cotton reel, strong rubber band, matchstick and pencil or wooden rod.

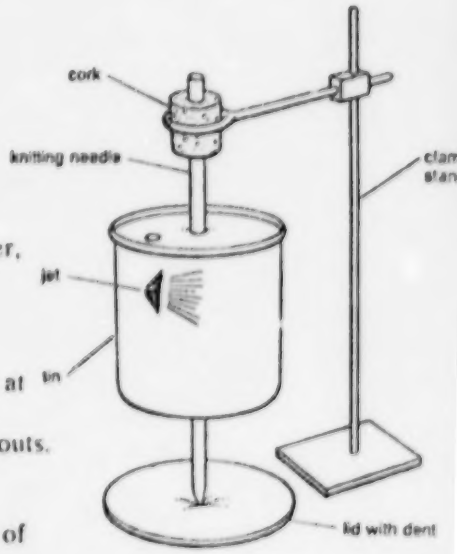
1 Pass the rubber band through the hole in the centre of the cotton reel.
2 Fix it at one end by using a matchstick or something similar.
3 Push a longer rod, such as a pencil, through the other end of the rubber band as shown.
4 Twist the rubber band by turning the rod several times.
5 Put the cotton reel down on the bench. What happens?



6 Wind it up again and see if you can make it climb a hill. What provides the energy to drive the reel?

A Simple Steam Engine

Equipment required: small tin, knitting needle or any similar metal rod pointed at one end, soldering iron and solder, cork, small screwdriver, clamp stand, boss and clamp, tin lid and Bunsen burner.



1 Push the knitting needle through the tin as shown, and solder it in position so that it acts as an axle.
2 Make two small cuts, 2 or 3 mm long and about 2 cm from the top, at opposite points on the side of the tin.
3 Insert a screwdriver into both these slits and twist it to make two spouts. Make sure that both spouts are pointing either clockwise or anti-clockwise round the tin.
4 Make a small hole in the top of the tin and fill the tin one-third full of water. Block the hole with a piece of cork.
5 Suspend the tin by its axle so that the top end can turn freely in a cork and the bottom end rests in a dent in another tin lid.
6 Heat the tin (avoiding the seams and soldered joints) until the water boils. What happens?

Figure 7.4.8 **AN ELECTROMAGNET**

Investigation: How can we make an electromagnet? How can we change the poles of an electromagnet? (P, I)

Background Information: When an electric current flows through a conductor, a magnetic field is generated around the conductor. The strength of this magnetic field can be increased by winding the wire into a coil around such magnetic material as an iron or steel nail or bolt.

Materials:
Insulated wire
Iron or steel nail or bolt
Dry cell
Switch
Paper clips
Compass

Procedure:
1. Wrap the insulated wire around the nail or bolt.
2. Attach the ends of the wire to the poles of a dry cell (see Figure 6-6). While not absolutely necessary, it is desirable to connect a switch into the circuit so that the circuit can quickly be broken. Children should be cautioned not to leave the switch closed for very long because this causes a great drain on the dry cell.

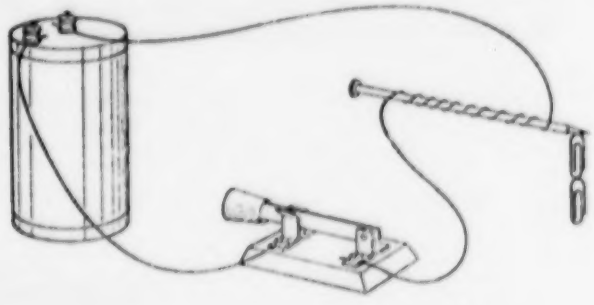


FIGURE 6-6. An electromagnet can be made by winding insulated wire around a nail or bolt.

3. Dip one end of the electromagnet into a pile of paper clips. Are the paper clips attracted to the end of the electromagnet?
4. Hold a magnetic compass near one end of the electromagnet and note which pole of the compass needle is attracted.
5. Change the connections of the ends of wire to the dry cell. This will reverse the direction that the electric current flows through the electromagnet.
6. Hold the magnetic compass near the same end of the electromagnet. Now which pole of the compass needle is attracted?

Going Further: Study the relationship between the number of turns in the wire coil and the strength of the electromagnet. See how many paper clips can be held in a chain at the end of the electromagnet. Now increase the number of turns in the wire coil. Does this affect the number of paper clips that can be held in a chain?

8.0 THE CHANGING NATURE OF TECHNOLOGY--Objectives

Students will be able to

- Recognize that technological changes are occurring at an ever increasing rate
- Understand that products evolve as a result of continuing technological discoveries
- Investigate the evolution of a particular technical product
- Predict future developments in the technologies studied in the Introduction to Technology course

8.0 THE CHANGING NATURE OF TECHNOLOGY--Teacher Guide

8.1 In order to illustrate the point that technological change is occurring at an ever increasing speed it is suggested that the teacher use the analogy of a 24-hour clock.

Authorities estimate that man the toolmaker has been on earth for roughly 240,000 years. If we take this figure and set it to the scale of a 24-hour clock, we would get a drawing like that in Fig. 8.1 Note that man spent 22 of the 24 "hours" in the Paleolithic, or Old Stone Age. During this time he lived in caves and first used crude stone tools. Just a short *two hours* ago he entered the Neolithic, or New Stone Age. At this time he made tools of polished stone, began to farm and raise animals for food, and invented the all-important wheel.

***One hour and twenty-four minutes* ago he discovered copper. *One hour* ago he learned how to make and use bronze. Now he had tools far superior to those of stone – stronger and sharper, lighter and easier to use. *Forty-eight minutes* ago he discovered iron, and learned to cast and shape it into even better tools. With the discovery of metals, man could make more efficient and dependable machines, and a variety of excellent products. He invented printing just *six minutes* ago.**

***Two minutes* ago the Industrial Revolution began. During this period appeared some of man's most significant inventions: Watt's steam engine; Arkwright's spinning machine; Whitney's cotton gin; and Maudslay's screw-cutting lathe. The factory emerges here, and machines become more efficient because of steam power. Man learned to produce and use electricity only *one minute and 18 seconds* ago. About *25 seconds* ago he flew the first airplane. Atomic power, computers, and space flight were born just a few *seconds* or *fractions of seconds* ago.**

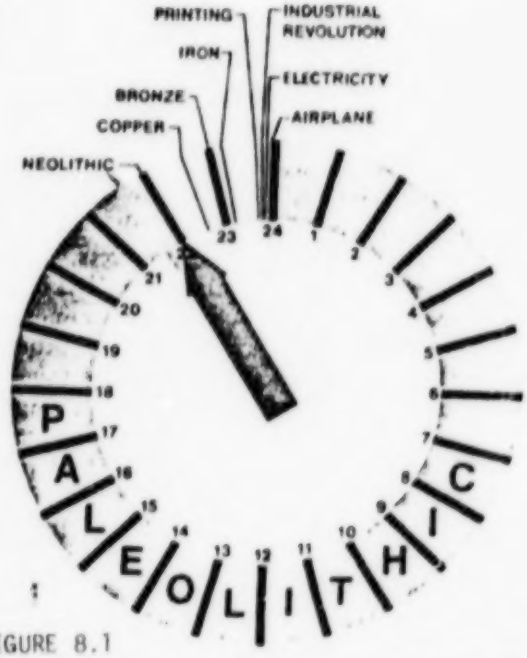


FIGURE 8.1

Each "hour" of this 24-hour clock represents 10,000 years. The time before the Neolithic is called the Paleolithic Age. This primitive era occupies nearly all of man's existence on earth.

In order to illustrate how rapidly inventions are occurring in this century as compared to previous times have students study the "Time line of selected events" found in their booklet.

8.2 After students have completed the exercise related to the "Time line of selected events" you should show an example of how one product or technical object has changed over a long period of time. The slides showing the evolution of man's ability to add numbers could be used.

8.2 CHANGING NATURE OF TECHNOLOGY

SLIDE SERIES: HISTORY OF COMPUTING

1. Man has always been interested in knowing how much he has. Stone Age man could not count, he only knew he has either one, some, or many things. He later learned to use his fingers and groups of stones to count.

2. The abacus was invented several thousand years ago. Groups of stones that had been used for counting were replaced by beads that could slide on a cane frame. In the hands of a skilled operator, an abacus can add as fast as a mechanical calculator.

3. Multiplication caused Europeans considerable trouble until John Napier invented "Napier's Bones" in 1617. These were strips of bone that could be slid side by side to give the product of two numbers.

4. The first mechanical calculator was designed by the mathematician, Blaise Pascal, in 1642. As a young man, he devised an automatic adding machine to help his tax collecting father keep the accounts. The heart of the machine was a device for carrying tens to the next column.

5. The Pascal calculator could only perform multiplication by repeated additions. In 1671, Leibniz extended the ideas of automatic calculating machines by constructing a multiplying device.

6. In 1804 Joseph Jacquard invented an automatic loom for weaving. He used patterns of holes which had been punched into cards to control the sequence of operation of the loom. This invention was to be used many years later as a basis to program calculating machines.

7. Charles Babbage was the first man to propose an automatic calculating machine in 1812. He wanted a machine that would continue calculating without attention from the operator. This is only a model of his "difference engine". Even though his theory was correct, the engine could not be constructed with the skills available at the time.

8. Lady Lovelace, the daughter of Lord Byron, had extraordinary mathematical ability. She collaborated with Babbage in the design of the programs for the difference engine, which she described in 1843. She has become known as the first programmer.

9. Dr. Herman Hollerith won a national contest to find a quicker way to process the U.S. Census. In 1886, Hollerith proposed an electromechanical machine that could tabulate data represented by holes punched into cards. This is an original card punch.

10. The holes punched into the cards could be read by electrical means and results calculated by using mechanical countries. Tabulators based on this principle were used up until the 1960's

11. In 1937, Dr. Howard Aiken of Harvard had the idea of using the components of punched card machines to produce an automatic calculator. He collaborated with IBM to produce MARK I in 1944 - 112 years after Babbage had proposed the idea. This was the first fully automatic computer to be completed.

12. Mechanical counters were known to be slow. Eckert and Mauchly from the University of Pennsylvania decided to replace the mechanical counters with electronic switches using vacuum tubes. ENIAC (Electronic Numerical Integrater and Calculator) was completed in 1946. This was much faster than MARK 1.

13. ENIAC was programmed by means of wires and switches. John von Neumann, also at the University of Pennsylvania, delievered a paper in 1946 proposing a new design for computers. He suggested that the program should be stored internally with the data. This would allow it to be changed easily. All computers since that time have been based on that principle.

14. The IBM 701 was released in 1952 as one of the first commercially available computers. This picture is of its successor, the IBM 704 installed in Paris, France, in 1953. This was later to become known as a member of the "first generation" of computers-based on vacuum tubes.

15. Originally, paper tape or punched cards were used to store data and programs when not in use. These were slow and not reusable. In 1950, the magnetic tape drive was introduced to provide high speed, reusable storage.

16. A particular item of data on magnetic tape could only be located by reading all of the earlier tape. This RAMAC (random access) device, introduced in 1956, allowed data to be rapidly retrieved from anywhere on the spinning discs.

17. The IBM Company had gained the lead in the computing industry with the release of the 701. This it ensured with the introduction of its highly successful 650 computer in 1955. Over 1,000 were installed.

18. All computer programs for the early computers had to be written in "machine" language. Programming was limited to engineers and mathematicians. In 1955, IBM introduced the FORTRAN language which allowed people without a specialized knowledge of computers to write programs. This was a most significant step for programming.

19. Computers were limited in their performance and flexbility by the cost and speed of the main storage. The introduction of magnetic core storage in the late 1950's removed one of the major barriers to the growth of computers.

20. The transistor was invented in 1947 and was seen as the sensible replacement to the vacuum tube. It was a fraction of the size and many times faster. It was not until 1959 that transistors were used in computers. This marked the "second generation" computers.

21. In 1959, IBM introduced the 1401 computer. This used transistors, magnetic cores, magnetic tapes and disks. Over 10,000 were installed, mostly for commercial use. It was by far the most popular computer to that time.

22. The major use of computers was now in the commerical area. FORTRAN was too scientifically oriented for commercial work. The U.S. Department of Defense standardised on a new programming language called COBOL--a business style language. It is still the most common language in use today and it represented an important step in the widespread use of computers by business.

23. The earliest means of getting results out of a computer were by typewriters or low speed printers. New business applications required large volumes of printed output. High speed printers, operating at around 1,100 lines per minute were released in 1961.

24. Airlines were among the first to realize the potential of combining computers and telecommunications. In 1962, American Airlines SABRE system connected offices all over the country to its large central computer, via telephone lines. It changed reservation systems for all times.

25. Ever-increasing demands of commercial computing meant greater data files. These sometimes had to be processed in any order like the earlier RAMAC file. In 1963/64 removable disk files were introduced. Now millions of characters of information could be take n from the storage cabinet and made available to the computer.

26. There were many different types of computers in 1964 for a wide range of tasks. Users of computers had difficulty changing from one computer to another. In 1965 IBM introduced the System/360--a single family of computers that replaced all its previous models. These were the first of the "third generation" computers.

27. At the heart of the processor the System/360 was a new technology--Solid Logic Technology (SLT). This combined a variety of the electronic parts into a single integrated circuit.

28. With the falling cost of computers and the rising cost of programmers, a new concept was introduced--of programming packages. This meant that the cost of programming could be shared by many users. For example, such was the case with a general reservation program for this manufacturing package.

29. The integrated circuits were improved and the early 1970s saw the introduction of the IBM System/370 with Large Scale Integrated (LSI) circuits. Now thousands of transistors were placed on a single chip of silicon. This chip passes through the eye of a needle. LSI marked the "fourth generation" computers.

30. Large scale integrated circuits allowed microprocessors to be built that would fit in a matchbox. The "intelligence" of computers need not only be in large central systems, but distributed in micro-computers for special purposes.

31. And what of the future? Communication between computers will be greatly improved through fibre optics. These carry many times the data that can be sent down a copper wire and will be the basis of your "neighourhood network".

32. New communication satellites with hundreds of thousands of circuits will allow people to communicate with each other, through computers, around the world.

33. Computer circuits will become smaller, faster and cheaper. Very Large Scale Integrated Circuits such as this contain 50,000 individual components. It will lead to pocket-sized computers.

34. Lasers are already used in new line printers that can produce 62,000 lines per minute. They will also be used to transmit data at phenomenal speeds down optical fibers.

35. New data storage devices will replace magnetic disks and tapes. Magnetic bubbles, shown here, promise far greater density of storage than magnetic disks. Video disks, designed initially for TV will allow the contents of an entire encyclopedia to be stored in a single disk.

36. This illustrates the reduction in size of computer components over the four generations in thirty years. The single chip contains the equivalent logic of thousands of vacuum tubes. Where will it end?

8.2 Students will be asked to prepare a research report on the development of a selected invention. Initially, they should be asked to select three possible choices in order that the teacher can ensure that a wide variety of topics will be studied.

It will be helpful if the teacher stresses certain points related to the development and completion of a research report/project. This report or project is not necessarily in written form. For example, simple models or mock-ups of the original object(s) together with actual modern day examples as a brief explanation of the difference might be more appropriate than simply a written report. To illustrate this idea we could consider the development of a hammer. The student might make four examples available in three dimensional form:

- rock
- rock tied to handle
- wooden handle and metal head
- metal shaft and head

These would be accompanied by notes explaining the period of time when such changes occurred and reasons for the changes. This project would normally be mostly constructed outside of regular class periods.

8.3 In your position as a technology teacher you must always remain up-to-date concerning changes taking place and future trends. It is important that students leave the course with the understanding that technology is in a state of constant change and that they should become partners in this evolving process. As a consequence, this last section should deal with predictions in the following areas:

Housing
Transportation
Medicine/Genetics
Food/Nutrition
Economics/Banking
Manufacturing
Space Technology

No materials have been attached for this section because you as the teacher can be the only one that maintains a current file of changes which are taking place on a daily basis.

Appendix I - Slides

Number(s)	Subject	Theme
1 - 2	Kitchen and Living Room	1.1
4 - 15	Structures	5.1
17 - 40	Simple Machines	6.1
42 - 80	History of Computing	8.2

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INTRODUCTION TO TECHNOLOGY
STUDENT WORKBOOK

JOHN GRADWELL
MALCOLM WELCH

McGILL UNIVERSITY - 1983

THESE MATERIALS WERE DEVELOPED BY MEANS OF A GRANT
FROM THE MINISTÈRE DE L'ÉDUCATION DU QUÉBEC
AND THE PROGRAMME DE PERFECTIONNEMENT DES MAÎTRES
DE L'ENSEIGNEMENT PROFESSIONNEL AT MCGILL UNIVERSITY

Slide Series

In these booklets reference is made to a series of slides which are essential to certain portions of the text. The series was assembled from a variety of sources and represents the kinds of ideas you will want to convey to your students.

It is recommended that teachers create their own set to suit their own individual needs. If necessary, the original series can be viewed by contacting John Gradwell at (514) 392-8844 or Malcolm Welch at (514) 637-2505.

INTRODUCTION TO TECHNOLOGY PROGRAM

AS ORGANIZED

FOR P.P.M.E.P. RESEARCH PROJECT

J. Gradwell, McGill University

M. Welch, P.S.B.G.M.

STUDENT WORKBOOK

INTRODUCTION TO TECHNOLOGY PROGRAM

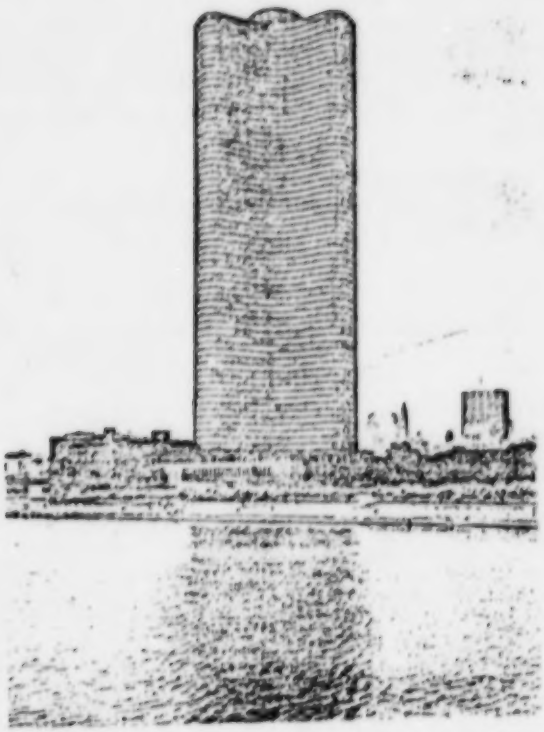
AS ORGANIZED

FOR P.P.M.E.P. RESEARCH PROJECT

1. Technology in the Life of Man
2. Graphic Communications
3. Creativity
4. Materials and Processes
5. Structures
6. Simple Machines
7. Power and Energy
8. The Changing Nature of Technology

0.0 INTRODUCTION

0.1



Describe what you did between getting out of bed this morning and arriving at school. Make a list of the technical objects and services that you used.

0.2 Try to imagine what your daily life would have been like 1000 years ago. Would the objects and services you identified above (0.1) have been available? If so, what would they have looked like? If not, how did people manage to live without them.

1.0 TECHNOLOGY IN THE LIFE OF MAN

1.1 Yesterday we looked at the world in which you live and discovered that it is a highly technological world. The slides you are about to see show a typical kitchen and living room, each of which contains many technological objects. Some of these satisfy basic needs while others are luxuries. Look at each picture carefully and identify as many technological objects as you can. Then write the name of each under one of the following headings:

a. objects essential for survival
b. objects whose absence would be a major inconvenience
c. objects which are luxuries

1.2

	KITCHEN	LIVING ROOM
a. objects essential for survival		
b. objects whose absence would be a major inconvenience		
c. objects which are luxuries		

1.3 Can you think of other objects (not necessarily only those in the pictures) which do not fit into any of the three categories? If so, list them below and think of a title for this group of objects.

	YOUR TITLE:

By grouping objects you have discovered that some are essential for survival, some add to your comfort and some serve only to make a profit for their manufacturers. However, all of them serve some purpose and fulfill a need.

1.4 Identifying a need and then producing an object to satisfy that need is one of the major tasks of technology.

Below is described a specific need which you or a member of your family may have:

Problem: Frequently when you answer the telephone you must take a message for some other member of your family. You have been given a stack of loose pieces of paper, measuring 4¼" x 5½". The problem therefore is to devise a method of holding this stack of paper in a tidy and convenient pile.

Limitations: Whenever a manufacturer is making an object he is often limited to certain materials. In this case you may only use the following - cardboard, white glue and tape.

1.5 Sketch as many different ideas as possible in an attempt to solve this problem. Feel free to add comments if this will make your solution easier for other people to understand.

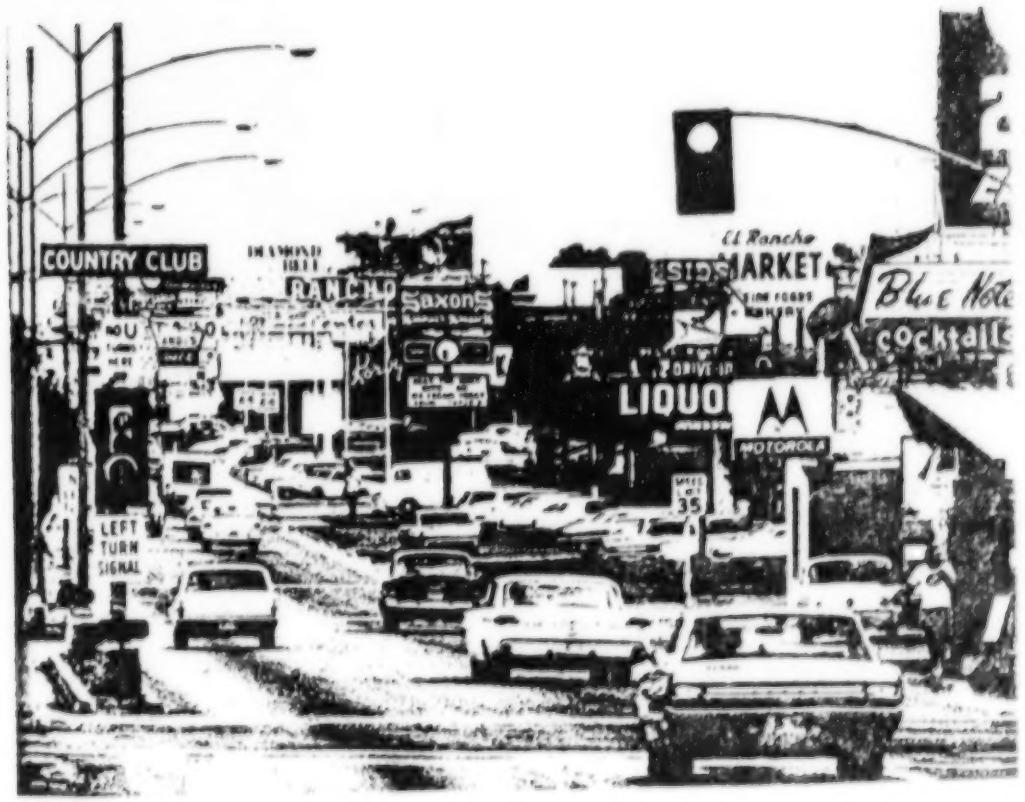
1.6 From the discussion of the class solutions you can see that there can be many different solutions to a single problem. However while your solutions vary, you have all worked through the same series of steps to arrive at your solution.

2.0 GRAPHIC COMMUNICATIONS

2.1 When you were designing the paper holder you had ideas which you wanted to put down on paper.

Perhaps you had some difficulty sketching or drawing your ideas. In some cases your drawings were clear to you but other people had difficulty understanding what they meant.

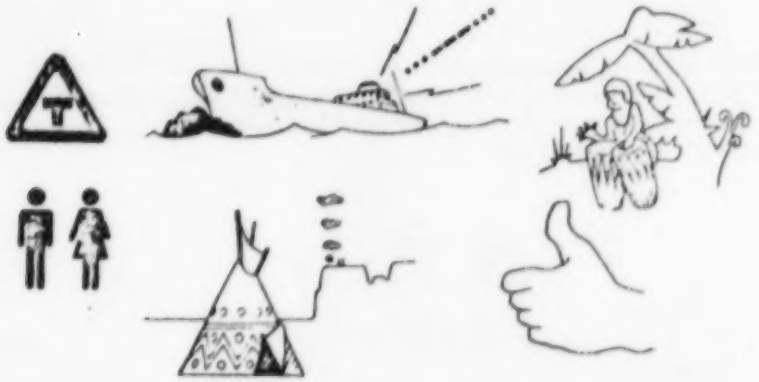
2.2 Attempting to tell other people about our own ideas is known as communication. There are many ways in which people communicate with one another; for example, by sounds, written and spoken words, gestures and symbols.



A busy street is full of signs and signals which give information to passers by. For example, shop signs tell shoppers what goods are for sale inside a building; road signs tell drivers what lies ahead as they drive; traffic lights give instructions to pedestrians and drivers to prevent accidents and create an even traffic flow.

This giving of information is called communication.

All types of communication use a code or language to represent the information in a convenient form.



Some forms of communication we use are described below:

Hand signs and sounds

How do referees and umpires communicate to the players?

Speaking

Sounds, made by our vocal chords, are shaped by our mouth and strung together to form words. Groups of words are formed into sentences to pass on a verbal message.

Writing

Letters are written symbols for the sounds of speech and have no meaning of their own. They began, usually, as pictures for objects in ancient times, e.g. the letter 'N' started as a snake in Egyptian times.

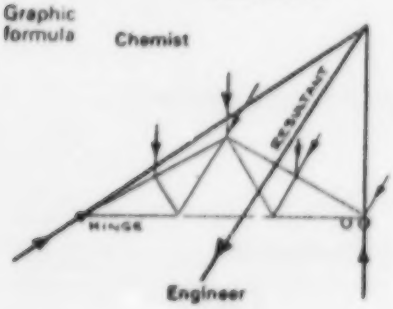
Graphic symbols and signs

Graphic symbols and signs are used to form visual languages for all to understand. Wherever groups of people with different speaking and written languages meet communication can be assisted by use of symbols.

Graphic formula

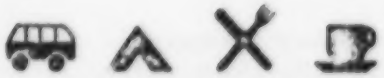
Pictorial diagram of the formula

Chemist



Engineer

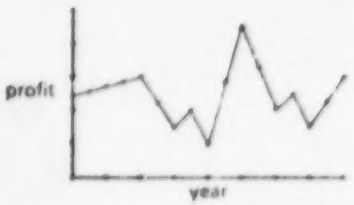
Musician



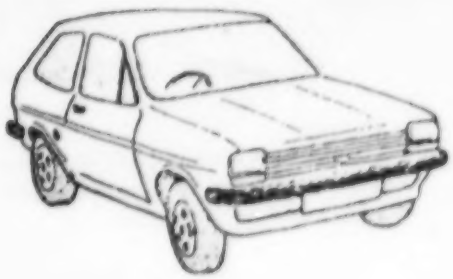
Tourist

Drawing Lines and shapes are used as symbols for objects and ideas.

A graph is a picture which shows how two values relate to each other.



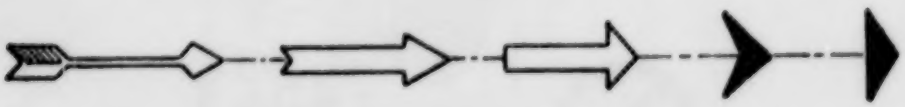
A drawing of an object is a symbol for that object. It is a graphic symbol.



To communicate effectively, only information which is necessary should be included: the message may be lost if too much information is given.

What happens in class if everyone answers at once?

Simple pictures and shapes are recognized quickly and easily—in fact, we learn to recognize the meaning of many very simple shapes once we know what they stand for.



2.3 **Look at the symbols below.**

Below you will find a list of what the symbols stand for. Copy this list in your notebook and put the number of the correct symbol alongside each meaning.

gasoline
sink
no smoking
disabled persons
bright sun
meter
falling rocks
family or group
uneven road

2.4 Having looked at some examples of internationally accepted symbols, you are now to try and create a symbol (without words) which will identify one of the following areas or activities in your school:

a. school dance
b. sports changing room (boys or girls)
c. library
d. hand tools
e. power tools
f. I.T.T. room

2.5 Another form of symbol is that used by industries and businesses to identify themselves. This type of symbol is known as a LOGO. The logo often suggests the activity with which the company is concerned.

Can you identify the company which uses the logo shown below?

Homework: From newspapers and magazines collect a minimum of six logos. Fasten them onto a sheet of white paper 8½" x 11".

Underneath each logo identify the company and/or product with which it is associated.

2.6 You have seen that a symbol can be very efficient when a simple idea or message has to be communicated. Often however the message to be communicated is quite complex. To show you how difficult it can be to communicate a more complex message we are going to play a game.

2.7 The game you have just played and the discussion which followed illustrated the difficulties involved in communicating and recording on paper an idea which has a number of parts.

Communicating complex ideas is a daily problem or task for the industrial engineer or architect. One form of communication used by these people is to record graphically their ideas using a technique known as ISOMETRIC DRAWING.

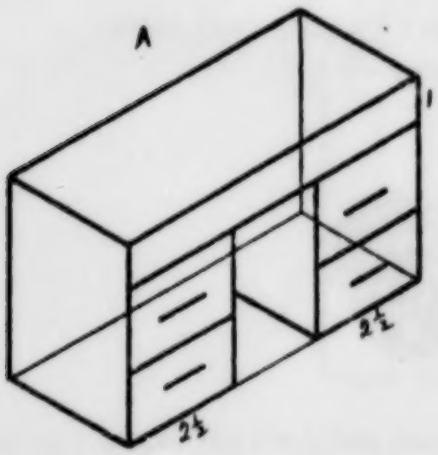
In order to learn the basic techniques of Isometric Drawing, work through the examples given by your teacher.

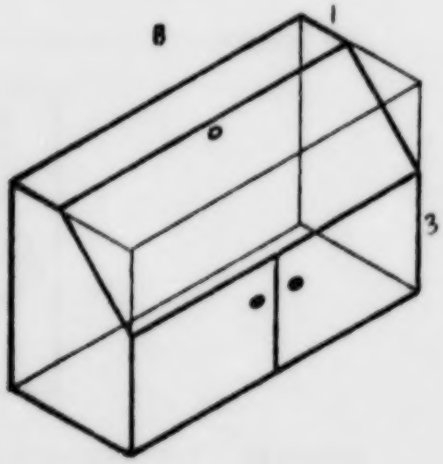
Now that you have learned how to draw an Isometric cube and how to remove parts from it, work through the following fun example:

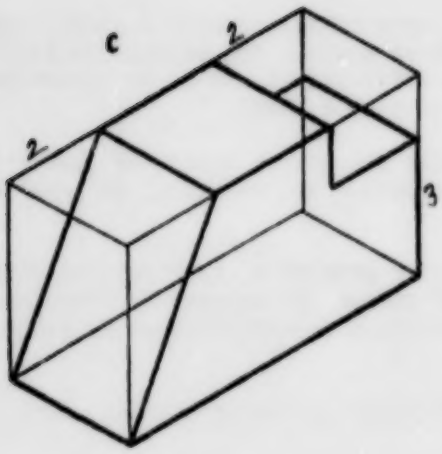
i. Draw an Isometric Cube with the following dimensions: length = 16 squares, depth = 12 squares and height = 14 squares.

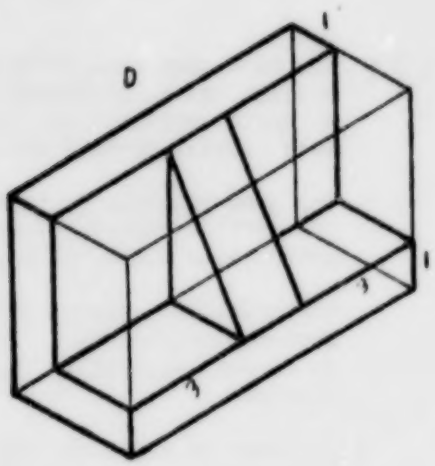
ii. By removing pieces of the cube and drawing holes in faces, create a "sculptured" block.

2.8 Draw the 4 isometric drawings shown below. Give each one an overall dimension of (L)9 x (D)4 x (H)5 squares.









2.9 You have now seen how Isometric drawings are a simple and effective method of recording your ideas and communicating them to other people. For the engineer however they do not provide enough information. What is missing?

To communicate dimensions as well as ideas engineers use another form of drawing, known as ORTHOGRAPHIC DRAWING.

You will now be shown the basic techniques used to construct orthographic views of a simple block.

2.10 Using the squared paper provided make orthographic drawings of the 4 objects shown in Figure 2.8.

2.11 If each square represents 15 cms what are the actual overall dimensions of the cabinet and desk shown in 2.8a and 2.8b?

3.0 CREATIVITY

3.1 When you were making the paper holder you discovered that communicating your ideas could be a problem.

In the last chapter you completed several exercises which taught you skills to record your ideas on paper in order to communicate them to other people.

You are now going to work through a series of design exercises which will use these new skills in a number of practical situations.

3.2 You are to design a storage box for one of the following groups of objects:

a. a set of tools commonly used in the home, e.g. hammer, screwdriver, pliers, adjustable wrench, nails, screws and glue.

b. shoe brushes and polish.

c. kitchen utensils, e.g. knives, forks and spoons or tin can opener, bottle opener, measuring spoons and whisks.

d. sewing kit, e.g. cotton reels, pins, tape, sewing chalk and scissors.

e. cassette or video game tapes.

The maximum external size for the box is 16" x 10" x 4" (400 mm x 250 mm x 110 mm). Be sure the items will fit into the box and its compartments. Your first task therefore must be to list and measure all of the items to be stored. Use the chart below to record this information.

ITEM	DIMENSIONS		
	length	width	thickness

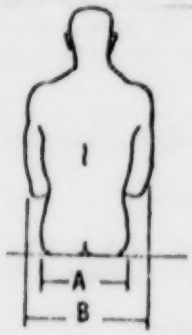
Do all of your planning on the Isometric paper supplied by your teacher. When you have decided on your best design make a clean, accurate drawing on a clean sheet of Isometric paper. Include a title and all of the dimensions needed to make the box. Feel free to add as many explanatory notes as you like.

Use a scale of 1 square = 1" (25 mm)

3.3 You have just completed a design exercise in which objects had to fit into a box.

Frequently it is people that have to fit into objects, e.g. a car, a telephone booth. One of the major tasks of the Industrial Designer is to ensure that objects will be comfortable, safe and easy to use by their owners.

One of the most common objects used by each one of us every day is a chair. Therefore in order to produce a well-designed chair the designer must know the size of the people who will be using it. This information is quite easy to obtain. The dimensions you need are shown in the diagrams below. Fill out the chart, using the members of your family as subjects. Note: You should only measure people over the age of 15 years. (Why?)



	NAME OF FAMILY MEMBER	DIMENSIONS (INCHES) A	B	C	D	E	F
1							
2							
3							
4							
5							
6							
	TOTAL						
	AVERAGE						

3.4 The process you have just worked through is a very simple example of SAMPLING.

Having collected data on an individual basis, it is now necessary to calculate an average for each dimension using all of the people surveyed. These averages can then be compared to averages which have been calculated for the entire adult population of Canada.

The steps you worked through are very similar to those used to compile National averages which would be used by Industrial Designers.

3.5 So far we have talked only about designing new products. Frequently however designing involves the modification of an existing project. Think, for example, of an easy chair. How could a living-room chair be modified (re-designed) to either make it more convenient or more efficient. To set you thinking, consider the effect of adding a pair of rockers to the legs.

Can you list other ways in which living-room chairs have been modified, and can you think of new ways?

3.6 Having looked at ways in which you can modify a chair, you are now to look around you and find other objects which could be modified.

Objects could be changed in a number of ways:

a. Used for a different purpose.

b. Borrowing a principle from one object and applying it to a new one.

c. Changing the shape of the object.

d. Reinforcing critical parts.

e. Eliminating parts.

f. Substitution of materials.

g. Rearranging parts.

h. Combination of existing ideas.

4.0 Materials & Processes:

4.1 In the first three activities you have seen that we live in a technological world. Most of the objects you see around you have been created by designers in order to meet a specific human need.

These designers gather their ideas and relevant data & record them on paper, in much the same way as you did in the last two exercises.

Once a designer has finished his plans, the next step is to select suitable materials to make the object.

4.2 Think of as many different materials as you can. To set you thinking, look at the objects around you in the I.T.T. room.

4.3 You are now going to make three projects using three of the materials you have identified.

	Material	Project
a	wood	candleholder or pencil holder
b	metal	I.D. tag or coathook
c	plastic	key fob or pendant

Each project should be completed in the following way:

i. Make several dimensioned sketches to show your ideas. Select the best one and have it approved by your teacher.

ii. Observe the demonstrations given by your teacher. These will show you the tools & techniques you will need to shape the materials to be used for your projects.

iii. Make your own project, using the materials supplied.

4.4 You have now worked with three different materials and used a variety of tools to cut and modify their shape. The next exercise asks you to think about the relationships between the tools and processes, and the materials.

Complete the chart below by checking (✓) the appropriate column.

MATERIAL / CHARACTERISTIC	WOOD	METAL	PLASTIC
1. pencil lines easily seen			
2. scriber lines needed			
3. centre punched easily			
4. saws with hacksaw			
5. saws with tenon saw			
6. saws rapidly			
7. can be filed			
8. can be rasped			
9. can be surformed			
10. drills rapidly			
11. drills with out splitting on the undersurface			
12. all surfaces need to be finished			
13. surfaces finished with emery cloth			
14. surfaces finished with garnet paper			
15. edges finished with a scraper			
16. finished surfaces require oiling			
17. finished surfaces require painting			
18. no finish required			

4.5 When you completed the last exercise you discovered that some tools were better suited to a particular material. Now you are to think about why certain materials are used in particular situations, eg. a bicycle frame would not be made of wood. (Why not?)

Complete the chart below. The first line has been completed for you as an example, i.e. wood is the warmest of the three materials, metal the coldest.

CHARACTERISTIC	LEAST ← → MOST		
warm to touch	metal	plastic	wood
transparent			
pleasant to handle			
good to look at			
weight			
hardness			
strength for standard cross-section			

4.6 Homework assignment:

Select three technical objects, each of which is made of several materials. For example, a bicycle, desk chair and record player. (DO NOT USE THESE EXAMPLES-THINK OF YOUR OWN). For each object list the materials used in its construction and state reasons why these materials were used for that particular part.

OBJECT	MATERIALS	WHERE USED	REASON
e.g. desk chair	metal wood fabric & foam	frame arms seat	strength/lightweight warm to touch comfort

5.0 Structures:

5.1 When you examined different products and the materials used for their construction, you found that some materials were chosen because of their strength. Strength is one important characteristic of a material, and particularly so in the types of objects you are about to study - namely, STRUCTURES.

A structure can be fairly simple and small, like a tent for example, or be large and complicated like a high-rise office block or a suspension bridge.

They all have to support loads to be of any value, but obviously the loads on a tent and a bridge are very different.

Although we shall be looking at man-made structures, there is also a vast array of structures to be found in nature.

Make a list of both natural and man-made structures:

	STRUCTURES	
	NATURAL	MAN-MADE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

5.2 In the definition of a structure we said that it was a "connected system of parts". Obviously, once connected the parts must stay together, i.e. the structure must be designed so that it will not fall down. Whether making a bridge or a high-rise the designer must work out the design of the structure in the same way.

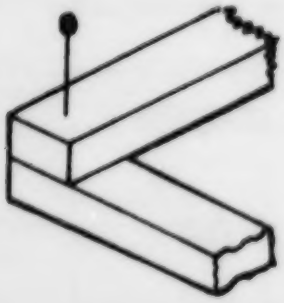
To be safe all structures must stay in shape when they are loaded. Only very small movements can be allowed. For this to be so, they have to be made in a certain way.

You are now going to conduct an experiment to show how a rigid shape can be made.

Method:

Cut off six lengths of Balsa wood each 100mm long. With these pieces make the geometric shapes shown in COLUMN 1 of the table. Join the corners with modelling pins as shown below.

DO NOT GLUE THE CORNERS.



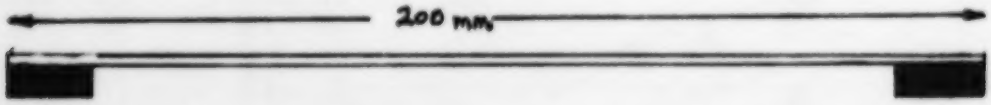
When you have made each shape hold one side firmly and push one other side. Record the results of the experiment in the table:

COLUMN 1	Did it change shape? (yes or no)	(1. greatest, 4. least) Rank shapes according to ability to withstand load

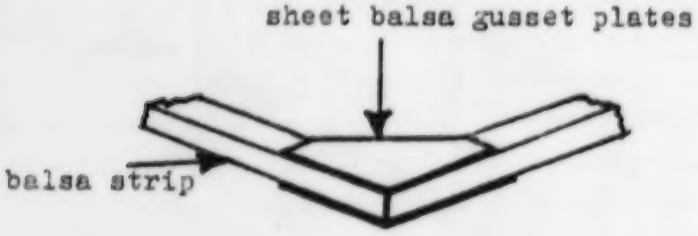
5.3 In the experiment you have just completed you discovered that the triangle was the most rigid of the four shapes. Using this knowledge you are to design a bridge to span a distance of 200mm. Your bridge must be designed to withstand the greatest possible load, and will be tested to destruction.

Read the following instructions carefully before beginning work:

1. Design a bridge to span a gap of 200mm. The bridge is to have a road or deck made from thin card (supplied).
   No single piece of Balsa is to exceed 135mm. in length.
   Only the amount of Balsa supplied may be used.



2. Gusset plates may be used to strengthen where members of the structure meet. (see diagram below).



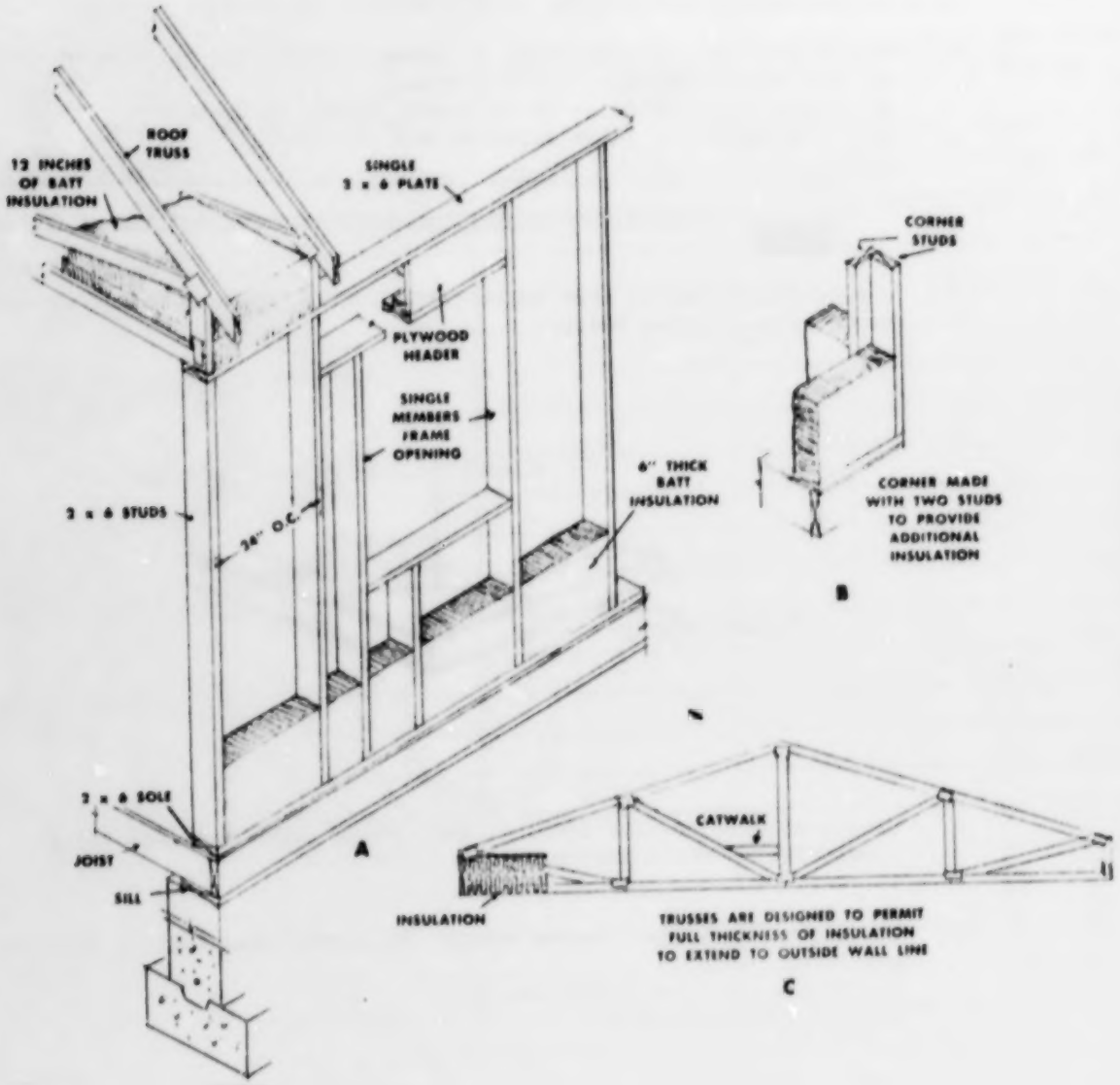
3. Make a drawing of your ideas on the squared paper provided <u>before</u> commencing to build your model.

4. Cut the balsa on the cutting board. Take care when cutting with the modelling knife.
   Pin joints together before gluing.
   Use the glue sparingly.

5. On completion of your model test it on the bridge testing rig for maximum load.

6. Comment on your design and make marks on your drawing at the points of failure of your bridge.

5.4 Having examined the structure of a bridge, you will see from the diagram below that a house also has a structure. You will notice some similarities between the bridge and the house, e.g., the truss roof which uses the rigidity of the triangular structure.



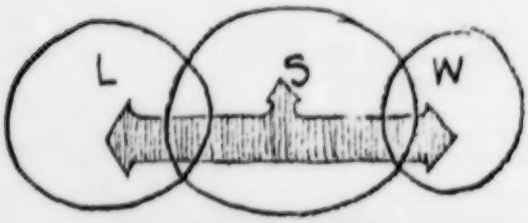
While the structure of your home is important, on a day-to-day basis we are more interested in the size and arrangement of the spaces in our homes.

As a homework assignment, fill out the table below.

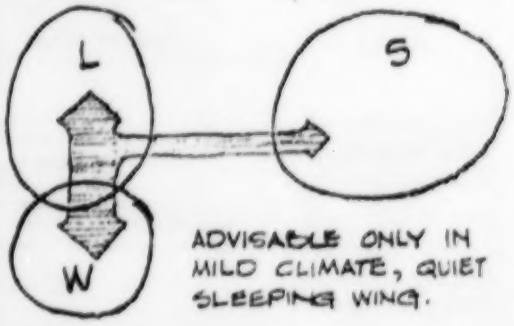
SIZE AND ARRANGEMENT OF ROOMS IN YOUR HOME				
1 ZONES	2 Name of Room	3 Dimensions Width x Length (m) (m)	Area (m^2)	Room(s) Connected by a Doorway
Food Preparation and Eating				
Living and Entertaining				
Quiet Area				
Bathrooms				
Storage				
Entries and Hallways				
Other				
		TOTAL AREA		

If you look at the list of rooms can you think of reasons to group certain rooms together, e.g. some activities require quiet.

Another important aspect of the arrangement of space in your home is the way in which people move between rooms, i.e. traffic patterns. Study the diagrams below and identify <u>three</u> which would be the most suitable for the geographic location in which you live.



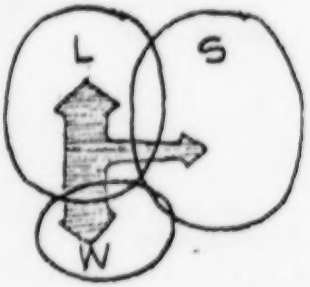
INADVISABLE, TRAFFIC LANES TOO LONG, LACK OF PRIVACY.



ADVISABLE ONLY IN MILD CLIMATE, QUIET SLEEPING WING.

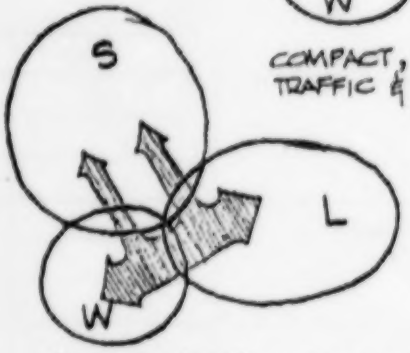
RAMBLING, INADVISABLE IN COLD, WINDY CLIMATE.

ENTRANCE SYMBOL

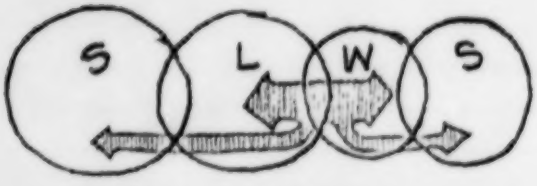


COMPACT, EFFICIENT TRAFFIC & HEATING

RAMBLING, VARIATION OF ABOVE



"ELL" OR "TEE" SHAPED, EFFICIENT TRAFFIC, CAN PROVIDE PROTECTED PATIO



VARIATION OF ABOVE, SEPARATE SLEEPING WING FOR GUESTS, RENTAL, ETC..

NOTES:

1. S = SLEEPING, L = LIVING, W = WORKING AREA
2. WIDTH OF ARROWS INDICATE RELATIVE AMOUNT OF TRAFFIC
3. ANY SCHEME MAY BE VARIED BY PLACING ANY OF THE AREAS ON ANOTHER LEVEL.

5.5 Using you knowledge of room sizes and traffic patterns you are now to design a single-level apartment, duplex or bungalow for a family of four people. You must include the following rooms:

a. dining room
b. living room
c. kitchen
d. at least 1 bathroom
e. at least 2 bedrooms
f. utility or storage room

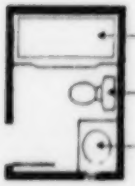
NOTE: Do not forget to leave space for hallways and closets.

The maximum size is 12 000 mm x 10 000 mm. Use the squared paper provided. Work out a suitable scale for your drawing.

Use the correct symbol from reference material provided to show the location of windows, doors, bathtubs, etc.

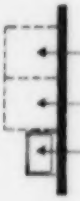
C.M.H.C. Modest House Designs
1978

	Identification of Rooms and Spaces	Identification des pièces et des espaces
1	Living	Séjour
2	Dining	Coin-repas
3	Kitchen	Cuisine
4	Bedroom	Chambre
5	Bathroom	Salle de bain
6	Washroom	Salle de toilette
7	Future Bedroom	Future chambre
8	Storage	Entreposage
9	Utility	Usages divers
10	Carport	Abri d'auto



Bathtub	Baignoire
W.C.	W.C.
Vanity	Coiffeuse

Counter	Plan de travail
Range	Cuisinière
Overhead cupboard	Armoire du haut
Counter	Plan de travail
Sink	Evier
Refrigerator	Réfrigérateur



Dryer space	Espace pour la sécheuse
Washer space	Espace pour la machine à laver
Laundry tub	Cuve à lessive

Hot water tank	Réservoir d'eau chaude

Furnace	Calorifère (fournaise)

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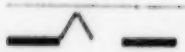
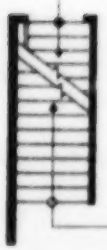
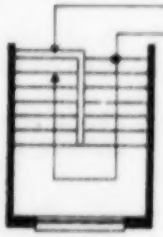
	Folding door	Porte pliante
	Hinged door	Porte battante
	Patio door	Porte patio
	Pocket sliding door	Porte coulissante escamotable
	Accordion door	Porte accordéon
	Window	Fenêtre
	Closet	Garde-robe
	Chimney	Cheminée

Stairs	Escalier
Down	Descente
Up	Montée
Balustrade	Balustrade
Down	Descente
Down	Descente
Balustrade	Balustrade
Up	Montée





5.6 Using the floor plan you have developed, construct a styrofoam model of the home you have designed.

Method

i. Cut around the outside walls of the floor plan and paste it to the Masonite (hardboard) supplied.

ii. Write your name on the underneath of the board.

iii. Using the styrofoam strips you have been given, mark off 4 pieces for the outside walls.

iv. Use the hot-wire cutter to cut the 4 walls to length.

v. Using a ball-point or fine felt-tip pen, mark the positions of the doors and windows.

vi. Use white glue and straight pins to assemble the 4 outside walls. Remove the pins before the glue is completely dry (10-15 minutes). If you wait too long the wall material may tear when you take out the pins.

vii. Layout, cut and erect the interior walls of your model.

a. Check one end of the interior wall material to make sure it is square. If it is not, trim it square.

b. Place the squared end of the material along one interior wall of the floor plan. Mark it to length.

c. Cut the material to correct length, being sure the cut end is square. If pieces do not fit properly sand them carefully until they do.

d. Using glue and straight pins, position the interior wall. Remove all pins after 10-15 minutes.

e. Repeat steps a - d for each interior wall.

6.0 SIMPLE MACHINES

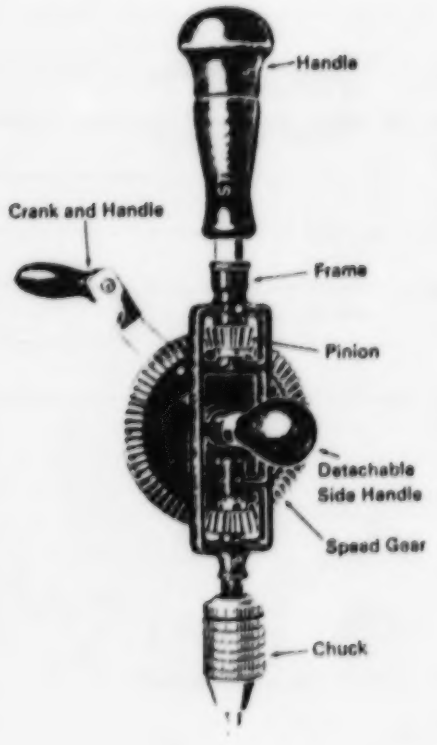
6.1 Inside most buildings you will find some type of machine. These machines range from the very simple, e.g. a pair of nutcrackers in your home, to the very complex, e.g. a computer controlled printing press in a factory.

When you look at most large machines they appear to be very complex. However, if you examine them closely, you soon discover that they are in fact composed of a number of simple machines.

In the slides you saw that we make daily use of such simple machines as the lever, inclined plane, pulley and gear.

The chart below asks you to list some objects which you encounter daily and to identify which simple machine(s) they incorporate. Write the name of the article in the space in the left-hand column. Put a check (✓) in the other columns to indicate which type of simple machine is involved.

For example, in the diagram of a hand-drill you **should be able to identify 3 simple machines;**



Hand Drill

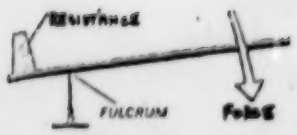
Machine			Lever	Inclined Plane (wedge & screw)	Pulley	Gear
1. Tools	a	Hand-drill	✓	✓		✓
	b					
	c					
2. Kitchen Equipment	a					
	b					
3. Sports Equipment	a					
	b					

- Using simple machines gives man several advantages and allows him to complete tasks which he otherwise could not do. List some advantages of using simple machines.

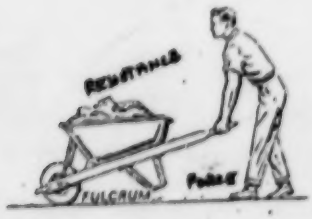
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

6.2 LEVERS

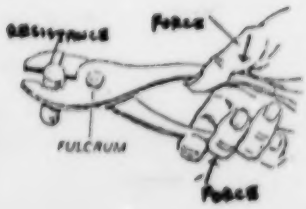
Each of the objects shown below uses the principle of either a class 1, 2 or 3 lever. Look carefully at each diagram and identify which class of lever is being used. Write your answers in the spaces provided.



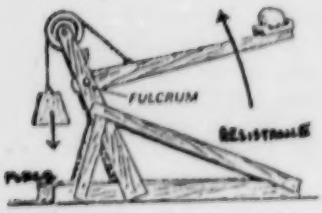
1. _____



2. _____

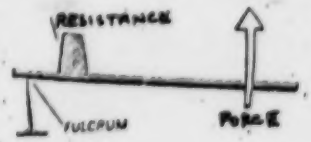


3 _____



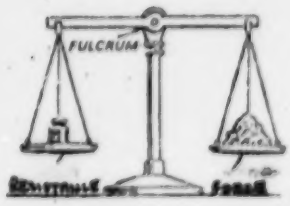
4. _____

5. _____

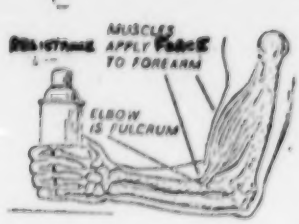


6. _____

7. _____



9. _____

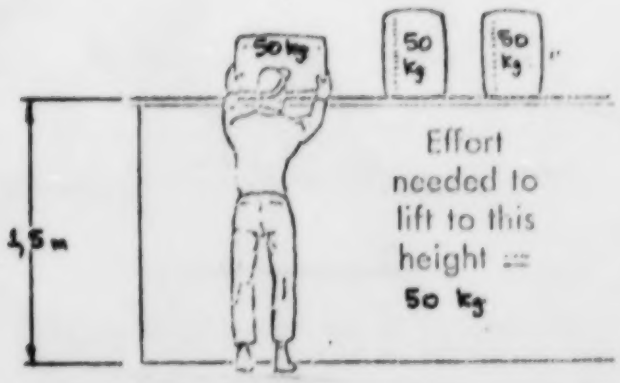


10. _____

8. _____

6.3 INCLINED PLANE

In the diagram below a 50 kg barrel has been lifted to a height of 1,5 metres. Perhaps you could lift this weight, but someone with less strength might find it impossible. Also if you had many barrels to lift you would soon become tired and unable to continue.

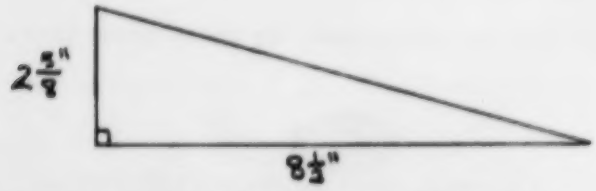


Can you devise a method, without any moving parts, to accomplish this task with less effort?

Use the squared paper provided to make a sketch of your solution. Use a scale of 4 squares = 1 metre (1 square = 250 mm).

The sloping surface you have just drawn is referred to as an INCLINED PLANE. If this inclined plane is wound around in a spiral, a new Simple Machine is created. Can you name this new machine? If not, work through the following simple experiment:

1. Mark out and cut a wedge of paper as shown below.



2. Starting with the widest end, roll the paper into a cylinder.

Now what simple machine does your model suggest to you?

6.4 PULLEYS

The inclined plane was a convenient way of raising a heavy object which was round (such as a barrel) and could be rolled, or had wheels (such as a bicycle). However, many heavy objects cannot be rolled or wheeled e.g. an engine block, load of bricks, bucket of concrete. In class you are going to use a weight to simulate a heavy object which has to be lifted vertically. The challenge is to devise a method of raising the block with the minimum of effort.

6.5 GEARS

1. Check your construction kit before removing any parts. Tell your teacher if anything appears to be missing.

2. Remove the large base plate.

3. Take out the two gears shown in the diagram below.

4. Count the number of teeth on each gear. Write the answers in the spaces below .

Larger	:	Smaller
_____	:	_____

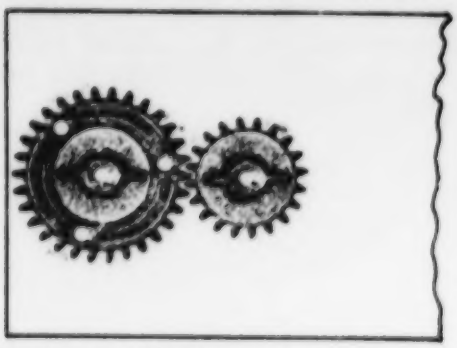
Now reduce these two numbers to their simplest form. (In this case divide each by ten). Rewrite them in the spaces below.

Larger	:	Smaller
_____	:	_____

You have now recorded these two numbers in the form of a RATIO.

5. Set up the two gear wheels as shown in the diagram below:

NOTE: Set up the gears at the left hand edge of the base board.



NOTE: Make sure that the wing-nuts are lined up as shown.

6. Rotate the larger gear through <u>two</u> complete revolutions, and observe carefully what happens to the smaller gear. Record your observations in the space below.

_____

_____

_____

_____

_____

7. Using the information you obtained from parts 4 and 6 complete the following table:

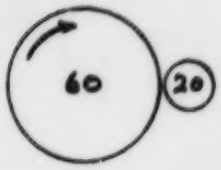
Number of Teeth (Ratio)			Number of Revolutions		
Larger	:	Smaller	Larger	:	Smaller
_____	:	_____	_____	:	_____

What do you notice about the two sets of numbers?

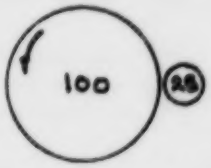
_____

_____

8. (a)



(b)



Look carefully at the gear assemblies shown above. Answer the following questions.

If the left gear is rotated through one complete revolution, how many revolutions does the right gear turn?

(a) _____ revolutions

(b) _____ revolutions

9. Using the diagrams in part 8 write the ratio for each gear system.

   (a) _____ : _____

   (b) _____ : _____

   Note: refer to part 4 for help.

10. (c)

   If the left gear is rotated through one complete revolution, what happens to the right gear wheel?

   _____

   _____

11. What is the gear ratio for this system?

   _____

12. Name three objects which use gear systems similar to those described above.

   (a) _____

   (b) _____

   (c) _____

13. Take out of your kit the two wheels and axles as shown below.

14. Using one small and two large blocks arrange the two wheels to operate efficiently as gears. (Put this second assembly as close to the first as possible).

15. Slowly turn one of the gears.

    How is the direction of rotation of the two gears similar to the first gear assembly?

    _____

    _____

    _____

16. The first gear assembly operated in one plane only, i.e. both gears were mounted horizontally.

    Describe how the gears in this second assembly are mounted.

    _____

    _____

    _____

    _____

17. Name an object which uses a gear system similar to the last one you constructed?

    _____

7.0 ENERGY RESOURCES

7.1 The exercise you have just completed demonstrates how dependent each of us is on a constant supply of electricity. So far, however, we have identified just a few of the electrical devices used in the home. Now try to list all of the devices in your home which need electricity. For each object, try to name a non-electrical alternative and comment upon how well it substitutes for the original.

Electrical Device	Non-electrical alternative	Effectiveness of alternative			
		Excellent	Good	Poor	Very Poor

7.3 Now that you are aware of the various sources of energy select one and, using the resource packs available from your teacher, answer the following questions.

1. Which energy source are you studying?

2. Is it available in the area where you live?

3. Where else in your country, or the world, is it available?

4. Is it easy to find these sources, or are they hidden?

5. How easy is it to utilize these resources and is the process expensive?

6. How are these resources distributed to where they are needed?

7. What forms of energy are derived from the source material?

8. How is the source material converted into an energy form ready for everyday use?

9. Is it possible to store either the source material or its converted form? If so, describe how this is done.

10. What are the environmental effects of man's use of this source material, e.g. pollution, health hazards, affect on the balance of nature, environmental damage?

7.5 As you must be aware from the many reports in newspapers, on the radio and television, certain energy resources are finite, i.e. they are not unlimited or renewable and once they have been used they cannot be replaced.

Because of this fact man must learn how to make the best use of the energy he now has at this disposal. Many of today's technologies are concerned with energy conservation.

As an optional activity, select one technical object which uses energy and research the ways in which technology is making it more energy efficient.

8.0 THE CHANGING NATURE OF TECHNOLOGY

8.1 Up to this point you have examined a number of technical objects. While many of them have been in existence for hundreds of years, quite obviously they have not always existed in their present form. All of the technical objects that you use today have undergone many changes since they were first invented.

Look carefully at the "Time Line of Selected Events" provided overleaf and answer the following questions.

1. How many objects were invented in the Old Stone Age and how long did this period last?

2. According to the time line how many objects have been invented in the 20th Century?

3. Name ten other objects which have been invented in the 20th Century?

4a. When was the wheel invented?

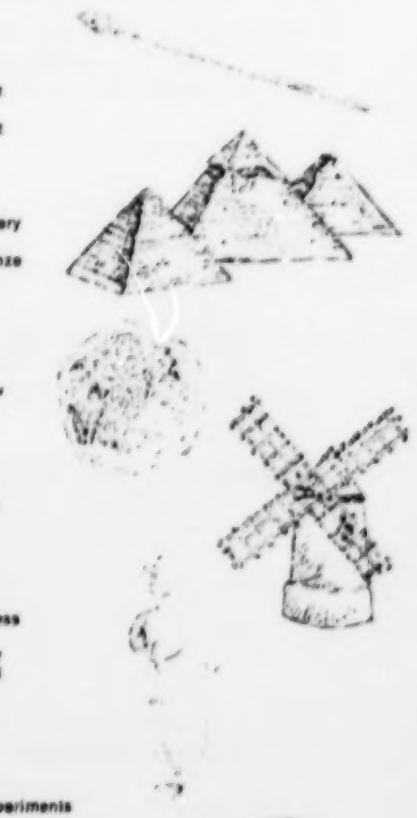
b. In which year did the first major change to the wheel occur?

c. What was this change?

d. What changes have been made to the wheel in this century?

Time Line of Selected Events, Technological Discoveries and Inventions

500,00 B.C.	Old Stone Age	Flaked hand-axes Wooden spears Probable use of fire Bows and arrows
10,000 B.C.	New Stone Age	Dugout canoe, reed boat Hoe and sickle Wheel used for transport
	Bronze Age	Hieroglyphics Cuneiform writing Stonehenge 365-day calendar Wheel used to form pottery Water wheel Smelting of copper, bronze Pyramids
2,000 B.C.	Iron Age	Phoenician alphabet Astrolabe Spoked wheel Vertical loom Etruscan alphabet Archimedes water screw First coinage Roman alphabet
1 A.D.	Roman Empire	Use of ink and paper Cross-bow
	Middle Ages	Development of steel Horse collar and saddle Windmill Stained glass Moveable type Magnetic compass Spinning wheel
1500 A.D.	Renaissance Age of Exploration	Gutenberg's printing press Galileo's telescope Newton's laws of gravity Blood circulation traced Pendulum
	Age of Enlightenment	Microscope Thermometer Air pump Barometer Slide rule
1700 A.D.		Franklin's electricity experiments Sextant
	Industrial Age	Steam engine Hargreave's spinning jenny Factory system begins Discovery of oxygen Power loom Cotton gin Smallpox vaccine Metric system Parachute Dental drill
1800 A.D.		Erie Canal Fulton's steamboat Morse's telegraph
	Machine Age	Sewing machine McCormick reaper Steel plow Gas lighting Fire extinguisher Blood transfusion Stethoscope Refrigeration



Water turbine
Bicycle
Trolleybus
Postage stamps
Matches
Braille
Assembly line
Clipper ships
Telephone
Barbed wire
Automobile
Electric motor
Bessemer converter
Transatlantic cable
Diesel engine
Radium discovered
Combine harvester
Wireless telegraph
Aspirin
X-rays
Steam turbine
Typewriter
Submarine
Radio
Dynamite
Wright brothers airplane flight
Helicopter
Vacuum cleaner
Safety razor
Conveyor belt
Zipper
Stainless steel
Rockets
Television
Geiger counter
Traffic lights
Hearing aid
Jet engine
Washing machine
Sonar
Radar
Iron lung
Synthetic fertilizers
Gas turbine
Ballpoint pen
Insecticides
Nuclear reactor
Aqualung
Moon landing
Automation
Microwave cooking
Polaroid camera
Long-playing records
Hovercraft
Spacecraft
Computers
Transistor
Lasers
Kidney machine
Cable television

Automation

1900 A.D.

Atomic Age

Space Age

Computer Age

Today

8.2 You have just seen a series of slides which illustrated how man's technological solution to a particular problem has developed over many centuries. You observed that not only did the object change its shape, but that the materials, methods of construction and manufacturing processes used also changed.

There are thousands of objects around in your everyday life which have undergone similar changes. Choose three objects whose historical development would interest you. Write the names of these objects below:

i _____

ii _____

iii _____

Once your teacher has approved one of the above selections, you are to prepare a research report on its historical development. Your final report may consist of notes, drawings, photographs, models, mock-ups or actual objects.

The following is a list of the kinds of questions that your research should answer:

1. Name of the invention

2. Who invented it, if known.

3. Where and when it was invented.

4. Stages in the historical development of the invention. Try to identify significant changes in construction, shape, materials and manufacturing processes.